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SPRAY and ROLLER

MILK DRYING EQUIPMENT

In the UNITED STATES

1940-1944

oOo

Capacity of Facilities in Use in 1940
Capacity of Facilities Added During 1941, 1942, 1943, and 1944
Capacity and Uses of Facilities in 1944

PRELIMINARY REPORT
FOR ADMINISTRATIVE USE ONLY
Not for publication

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Dairy Products Division
Dairy & Poultry Branch
Office of Distribution
War Food Administration
Washington, D. C.

OCT 23 1945

D O Y O U W A N T T O K N O W

THE WHOLE STORY IN A NUTSHELL?

Then see the SUMMARY on the next two pages (immediately following),

as well as Figure 1, on page 6 and Figure 2, on page 16.

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S U M M A R Y

Spray and roller facilities for the production of human-food dried milk products:

In use during 1940:

Had sufficient capacity to produce over 150,000 pounds of dried non-fat milk solids per hour. There were 419 equipment units.

Were located in 280 factories, situated in 31 states. (Over 55 percent of the facilities were in New York, Wisconsin, and California.)

Operated, on the average, 6.6 hours daily.

Produced 370,000,000 pounds of dried milk products during that year.

Added during 1941 - 1944:

Increased the capacity for the manufacture of dried non-fat milk solids by over 200,000 pounds per hour. This increased capacity came from:

New units, over 130,000 pounds;

Re-conditioned units, over 50,000 pounds, net;

(Nearly 14,000 pounds of re-conditioned capacity was replaced by new equipment.)

Re-located units, nearly 20,000 pounds.

Were placed in areas where milk production was high, but where its utilization for human food was low.

Half of the capacity increase took place in Wisconsin and Minnesota.

(Summary continued on next page.)

During the four-year period, 1941 - 1944:

Processed decreasing volumes of skim-milk for animal feed each successive year.
(1940 production was 160,000,000 pounds; in 1943 it was down to 24,000,000 pounds, with a continuing downward trend.)

Processed increasing volumes of buttermilk for human consumption each successive year.
(In 1940 comparatively little was processed for human use; 1943 production rose to 30,000,000 pounds, with the upward trend continuing.)

Converted into human food much skim-milk formerly used for casein manufacture.
(During the two years prior to 1944 casein production was cut in half.)

Were also used for processing foods other than milk.
At least 42 drying units equipped to handle milk have been used for egg drying. Capacity, over 22,000 pounds of dried non-fat milk solids per hour.

Available for use during 1944:

Totalled to over 1000 equipment units, and were located in nearly 650 factories. These units had a combined capacity of over 350,000 pounds of dried non-fat milk solids per hour.

Reported production of dried whole-milk and dried non-fat milk solids (by July 1) from factories having a combined capacity of 260,000 pounds of dried non-fat milk solids per hour.

Operated 7.9 hours daily, on the average.
(Based on an estimated production of 750,000,000 pounds of dried whole-milk and dried non-fat milk solids for the year.)

Placed as "Lend-Lease" equipment (by August, 1944):

Had a combined capacity of 14,485 pounds of dried non-fat milk solids per hour of operation, and the 4 factories which had operated a year or over:

Had an average daily operation period of 12.8 hours;
Exceeded anticipated production by 55 percent.

I. INTRODUCTION

THIS REPORT is an analysis of the available data on the capacity of the milk-drying equipment in the United States. The report is confined mainly to the equipment used for the manufacture of human-food dried milk products, and within the limits of the available data, shows:

1. The amount of available milk-drying equipment in existence in the United States in 1940, and the uses made of this equipment at that time.

2. The post-1940 additions to the equipment suitable for the manufacture of human-food dried milk products, the amount and type of this equipment, and the years in which it became available for the processing of human food.

3. The amount of equipment which has ceased to process human-food milk products during the four-year period, 1941-1944.

In this report, the above analyses are made with reference to:

1. The type of equipment (spray and roller).

2. The condition of the equipment when employed for the manufacture of human food (new, re-conditioned, or re-built).

3. The kind of dried milk product manufactured at the factory prior to the manufacture of human-food dried milk (if any). (Whether animal-feed dried skim-milk, or dried buttermilk.)

The data on which these analyses are based were obtained mainly from these sources:

1. The reports of the 1941 and 1942 Milk-Drying Equipment Surveys, which were conducted by the Bureau of Agricultural Economics.

2. Information furnished by applicants for equipment priorities.

3. Information obtained from field inspection reports. 1/

1/ For a complete list of the sources of information, see Appendix.

I.

Limitations to Keep in Mind when Interpreting this Report

In the interpretation of the data herewith presented, it is well to keep in mind that :

1. The capacities here shown are subject to variations.

2. It is probable that some of the equipment here listed is no longer available for human-food processing.

Since 1940 so much has been learned about the operation of milk-drying equipment that it is now often possible to manage facilities so that they will process milk at a higher rate than at their formerly rated capacity. In many cases auxiliary equipment has been added, and this has further increased the initial capacity, and the operating efficiency.

The total situation has been such that the equipment owners have been particularly careful to keep their facilities in good condition, with the result that few pieces of equipment have been discarded. But there doubtless are some pieces which, although counted in the following calculations, have found non-food uses, or are idle, or discarded.

The two factors, obviously, tend to cancel each other. That does not make these capacity calculations 100 percent accurate, but they are probably as accurate as it is possible to obtain under current circumstances.

Re: Capacity Figures Shown in this Report

With a few exceptions, capacity figures shown in this report are on a "per hour" basis. Many milk-drying equipment units are used only during the seasons of high milk production; e. g., during the period when the milk supply exceeds the demand for fluid milk for direct human consumption. Other units are operated in areas where they receive milk continuously throughout the year; but even with these, the volume of milk received is likely to be only half as much in November as it is in June. Thus an "annual capacity" figure is difficult to determine for any given piece of equipment, and for that reason it is felt that fair comparisons could be made only if capacities were listed on the "per hour" basis.

II. The EQUIPMENT SITUATION in 1940

1. HUMAN-FOOD DRIED MILK MANUFACTURE

Four Hundred and Nineteen Equipment Units Used in 1940 For the Manufacture of Human-Food Dried Milk; Combined Capacity in Pounds of Dried Milk per Hour of Operation, 152,910

In 1940, the year before the inauguration of the Government-sponsored program for increasing dried milk supplies, 271 factories reported the manufacture of dried skim-milk for human consumption.2/ In addition to these, 9 more factories using the spray and roller types of equipment reported the production of other human-food dried milk products.3/ (Table 1, and Tables 1-a and 1-b, Appendix)

Table 1. 1940 Equipment Status of Spray and Roller Factories Reporting Human-Food Dried Milk Production for that Year.

Number of factories	Products processed at factory	Spray		Roller		Combined capacity per hr.*
		Number units	Capacity per hr.*	Number units	Capacity per hr.*	
271	Skim-milk **	144	74,860	260	72,085	146,945
9	Whole-milk and other ***	5	3,750	10	2,215	5,965
280	U.S. Total	149	78,610	270	74,300	152,910

* In pounds of dried non-fat milk solids; based on manufacturer's ratings, or on the statements of the dried milk factory operators.

** Some of these factories also manufactured dried whole-milk, or other human-food dried milk products.

*** Includes only a few of the malted milk powder factories, as most of these use equipment radically different from the common spray or roller types.

2/ From "Dairy Production and Prices, Sales, and Stocks of Specified Dairy Products, 1941, and Production, by States, of all Manufactured Dairy Products, 1940", a publication distributed by the Bureau of Agricultural Economics. This lists 273 factories, but due to a misunderstanding, two factories reported dried skim-milk production for themselves when they actually sent their milk to other factories to be processed.

3/ From records in the Division of Dairy Statistics, Bureau of Agricultural Economics (unpublished).

These 280 factories had, in 1940, a total of 419 equipment units, of which 270 were roller driers, and 149 were spray driers. 4/

On the basis of the manufacturers' ratings and the statements of the dried milk factory operators, the combined capacity of these 419 equipment units was 152,910 pounds of dried non-fat milk solids per hour of operation. Thus, had these factories been able to operate their equipment 10 hours daily on the average throughout the year, they should have produced over 550,000,000 pounds of dried milk products.

Over 370 Million Pounds of Dried Milk Products Manufactured in 1940

The actual reported production for 1940 was 321,843,000 pounds of dried skim-milk, and 29,409,000 pounds of dried whole-milk. In addition to this, however, these factories produced an estimated 20,000,000 pounds of dried buttermilk and whey for human use, and some malted milk powder. 5/ Thus the total 1940 production of these 280 factories was over 370,000,000 pounds of human-food dried milk products. This indicates that during 1940 the milk drying equipment used for the manufacture of human-food dried milk products was operated, on the average, 6.6 hours daily. The States which led in the manufacture of human-food dried milk products, and which had the greatest capacity for drying milk, were: Wisconsin, New York, and California. (See Map No. 1.)

2. ANIMAL-FEED DRIED MILK MANUFACTURE

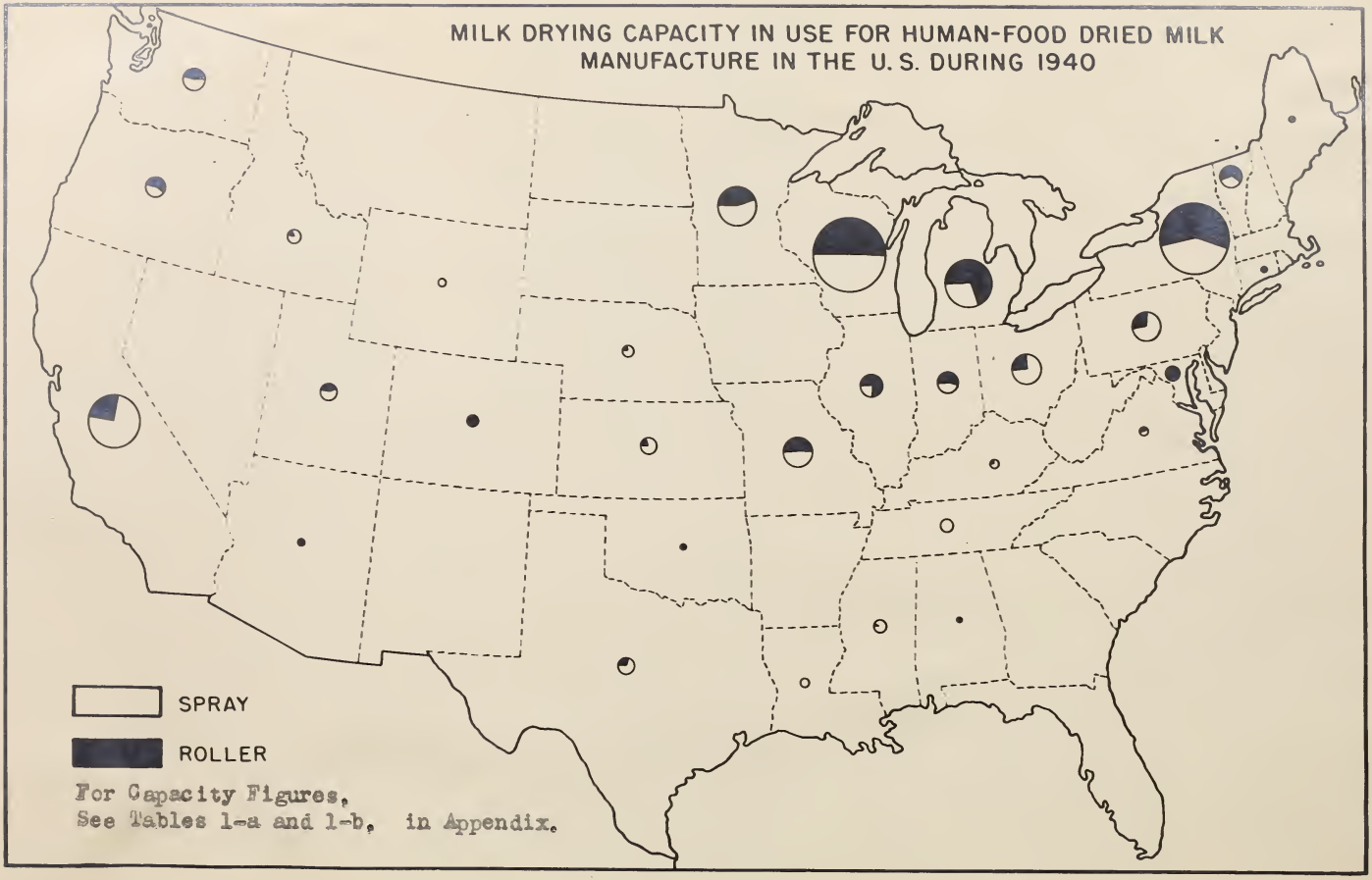
In 1940 Over 300 Factories Were Producing Animal-Feed Dried Skim-milk

A total of 321 factories reported the manufacture of dried skim-milk for animal feed in 1940. Many of these, however, are the same ones that produced the human-food dried skim-milk. Factories producing dried skim-milk, especially if they are using the roller process, sometimes inadvertently manufacture some dried milk which does not meet the standards required for human food. Some of the raw milk becomes too sour, or is unfit for other reasons; or the temperature of the processing equipment may be held too high. And some factories also had (in addition to equipment suitable for the processing of human food), some units fit only for the manufacture of animal feed. Thus, if the volume of milk received at such factories was beyond the capacity of the human-food equipment, circumstances forced the manufacture of animal feed.

4/ From unpublished records of the 1941 and 1942 Milk Drying Equipment Surveys, supplemented by information from priority applications.

5/ Only those malted milk powder factories using spray or roller equipment are considered in this report. Most malted milk factories do not use spray or roller processes.

MAP I


MILK DRYING CAPACITY IN USE FOR HUMAN-FOOD DRIED MILK MANUFACTURE IN THE U. S. DURING 1940
SPRAY
ROLLER
For Capacity Figures, See Tables 1-a and 1-b, in Appendix.

Over 300 Factories Were Producing Animal-Feed Dried Buttermilk in 1940

In 1940 there were 324 factories which reported the manufacture of animal-feed dried buttermilk. Most of the factories in this group have found, in the past, that a drying unit is the solution of the very vexing problem of by-product disposal. Usually, the lower the grade of the raw product coming to the factory, the greater the problem of the disposal of the buttermilk. Thus, for several reasons, the equipment used for the production of animal-feed dried buttermilk is usually too poorly located to be useful for the processing of dried milk products for human consumption. Prior to 1940 only a small percentage of the total dried buttermilk was processed for human consumption.

Over 500 Equipment Units Used in Animal-Feed Manufacture in 1940.

During the course of a year's time a factory, and a given piece of equipment, can be used to manufacture several products, both for human use and for animal use. Thus an analysis of the 1940 records of the Dairy Statistics Division of the BAE shows that 143 of the 321 factories reporting animal-feed dried skim-milk also reported the manufacture of human-food dried skim-milk. Thus 178 of them manufactured dried skim-milk for animal use exclusively.

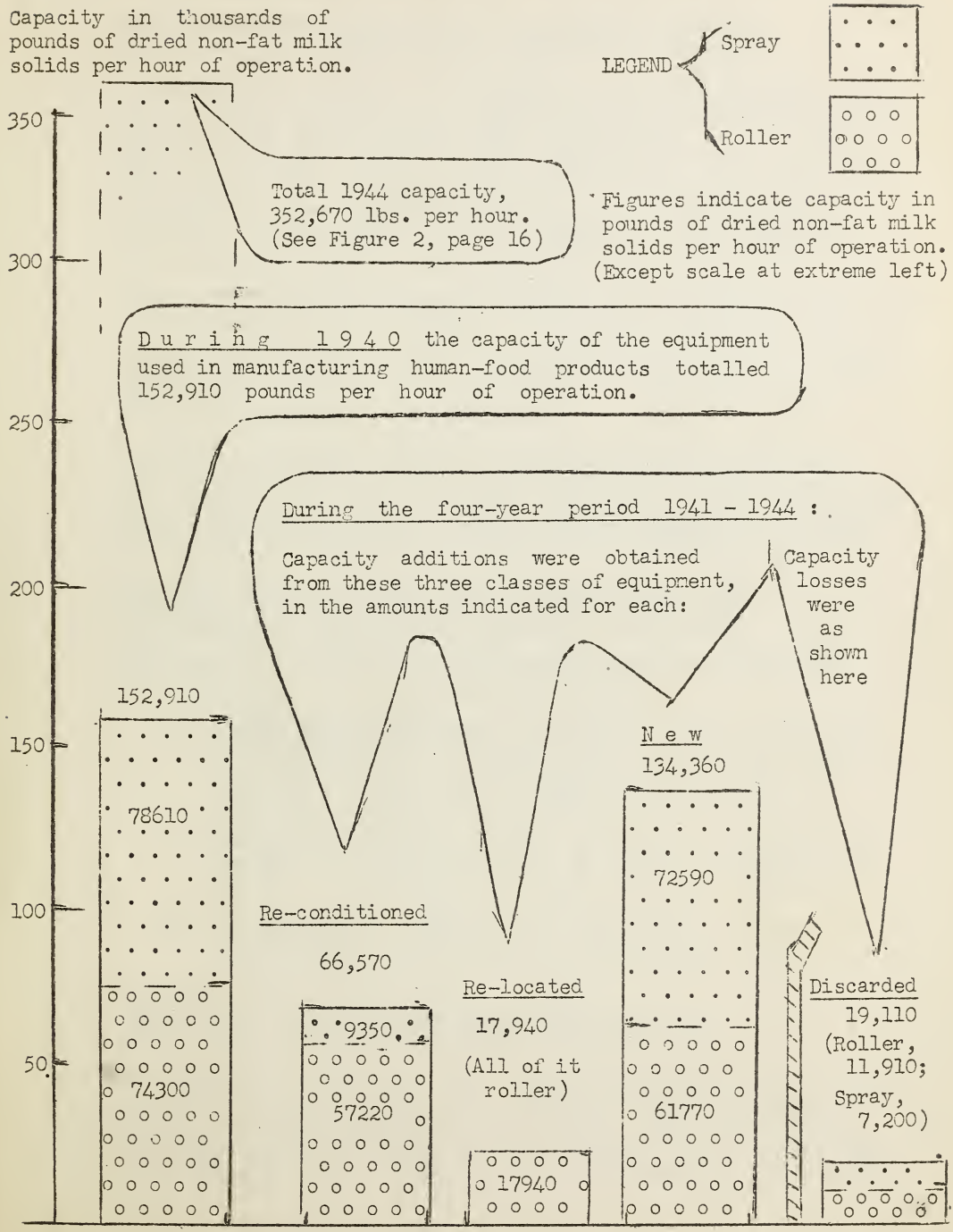
Available data do not indicate the extent of overlapping between animal-feed dried buttermilk and animal-feed dried skim-milk manufacture. Available data do indicate, however, that in 1940 at least 500 equipment units were used for the manufacture of animal feed. 6/

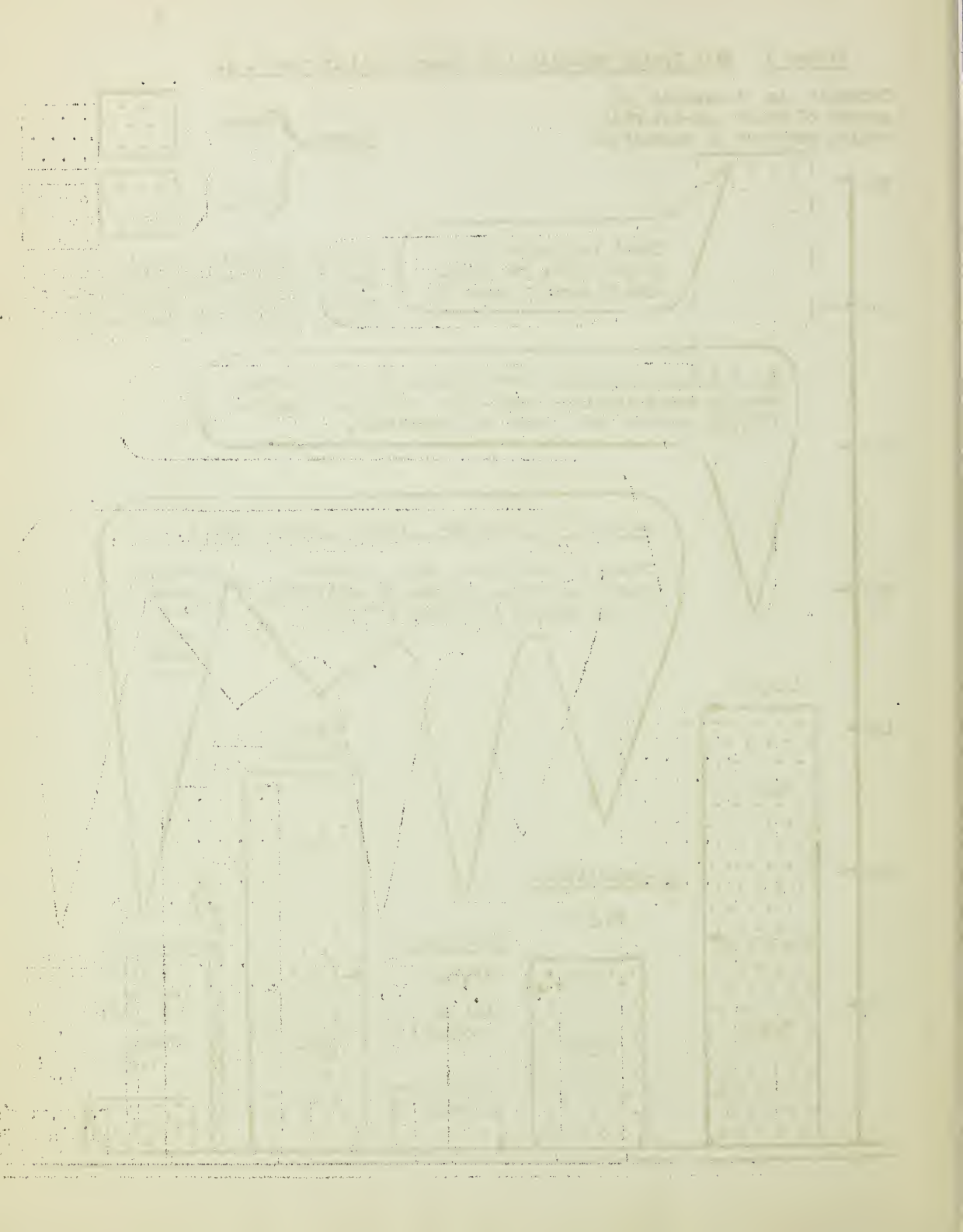
3. "STAND-BY" AND IDLE EQUIPMENT

It is common knowledge that some factories keep milk drying equipment as "stand-by facilities" to be used in case other facilities are overloaded or break down. Consequently, during some years some of these pieces of equipment are not in use at all. For 1940 the exact number and combined capacity of this class of equipment is not known. Even the Milk Drying Equipment Surveys of 1941 and 1942 failed to reveal how much equipment was so used; the owners usually stated that they were manufacturing animal feed or human food, even though they later failed to report such production to the Dairy Statistics Division of BAE. However, it is known that much of the "stand-by" equipment was brought into use during the 1941 - 1944 period.

6/ From an unpublished list of such plants compiled by, and in the files of the Dairy & Poultry Branch of the Office of Distribution, War Food Administration. (Compiled in 1943, revised in 1944, January.) The main source of data from which this list was compiled was "Who's Who in the Butter, Cheese, and Milk Industries", but additional data from other sources were also used.

Figure 1. Milk Drying Capacity (for Human Food) in the U. S.





III. EQUIPMENT ADDED SINCE 1940

The War Necessitated the Conversion of Animal Feed Into Human Food, But It Also Limited Processing Equipment

The Government's wartime food program, as announced in 1941, necessitated, among other things, a large increase in facilities for the manufacture of dried milk for human consumption. The facilities which in 1940 were devoted to the production of human-food dried milk products were inadequate to carry the additional wartime load; furthermore, these same facilities were often poorly located with reference to the available raw milk supply. New facilities were needed in areas producing farm-separated cream in suitable volume.

Because of the wartime demands for metals, the problem of increasing the capacity for the manufacture of human-food dried milk could be only partially solved by adding new equipment. This put a premium on equipment then in use for animal feed manufacture (or idle), especially if it could be re-conditioned or re-located without too much difficulty. (See Figure 1.)

Increased prices for human-food dried milk products were added incentives to converting from the manufacture of animal feed to that of human food. The "spread" between the prices for the two products was wide enough to induce many manufacturers to attempt the manufacture of human food instead of animal feed.

Increased Capacity Came From Re-conditioned and Re-located Equipment as well as from New Facilities

Expansion of the facilities for the manufacture of human-food dried milk have come from three main sources:

1. Reconditioned Equipment. Facilities in use in 1940 for the manufacture of animal feed were rebuilt and refitted with sanitary accessory equipment, thus permitting the processing of human food instead of animal feed.
2. Relocated Equipment. Equipment that was idle because of changes in market conditions, or for other reasons, was shifted to localities where ample milk was available.
3. New Equipment. New equipment was added to already-existing facilities, and new factories were built.

Conversion From Animal Feed Offered Possibilities for Increasing Human-Food Dried Milk

The 178 factories which in 1940 reported the manufacture of dried skim-milk for animal feed only, offered possibilities for the increase of human-food dried milk because they were already receiving whole milk, and they had equipment that, with proper reconditioning, could be made suitable for human-food manufacture.

These factories can be classified into three main groups:

1. Creameries. "Country plants" processing milk coming directly from producers. These are located mostly in rural areas in which hog population is low, with a consequent low demand on the part of the farmers for skim-milk to be used for animal feed. Many of these factories also had buttermilk drying units.

2. "Surplus milk" factories. The factories which receive more raw milk than they can utilize as market milk, particularly during the months of peak production. Such factories sometimes lacked enough of the proper kind of equipment capacity to manufacture this excess milk into cheese or evaporated milk. Much of this excess milk was then manufactured into human-food dried milk products, except in cases where the drying equipment was unfit for human-food processing; in such cases the milk was turned into animal feed.

3. "Return milk" factories. These are dairies in large urban centers in which some of the fluid milk which is bottled and put into the channels of trade, fails to reach the consumers' tables, and for a number of reasons is "returned" to the dairy processing plant in which it originated. Often these plants then salvage the milk by processing it into dried milk.

Exact classification of factories into the above three groups is difficult, but it is evident that most of those which have converted from animal feed to human food manufacture are creameries receiving their milk directly from the farmers. The manufacturing facilities which they already had on hand were easily reconditioned in most cases; and their prospects for increasing their raw milk supplies were good, especially with an increased price as an inducement.

The "surplus milk" factories could convert from animal feed to human food just as readily as the creameries. But the increase in dried milk production is not so marked in this group of factories, because they often increased their capacity for manufacturing the other products that utilize all of the milk.

Not many of the "return milk" factories have attempted to convert. The available milk is usually of poor quality, and probably there is less "return milk" nowadays than there was a few years ago.

A few factories that made the change from animal-feed to human-food dried milk have again ceased the production of the human-food product. Apparently they have found that their equipment or their raw milk are not suitable.

Two Hundred Sixty-five Equipment Units Formerly Used for Animal Feed Were Reconditioned and Used for Human Food; Combined Capacity in Pounds Dried Milk per Hour of Operation, 66,570

At least 112 former animal-feed dried skim-milk factories have, since 1940, reconditioned and converted their equipment so that they have manufactured dried milk products for human use at least part of the time during the past four years. These 112 factories had a total of 136 equipment units with a combined capacity of 34,660 pounds of dried skim-milk per hour of operation (Table 2).

Table 2. 1940 Equipment Status of Spray and Roller Factories Which, Since 1940, Have Converted From Animal Feed To Human Food Manufacture.

Number of factories	Product processed, if any	Spray		Roller		Combined capacity dried milk per hour
		No. of units	Capacity per hour	No. of units	Capacity per hour	
112	Skim-milk *	5	2,000	131	32,660	34,660
110	Buttermilk and "stand-by" facilities **	18	7,350	111	24,560	31,910
222	Total	23	9,350	242	57,220	66,570

* In addition to these 112 factories, at least 5 more which were manufacturing animal feed in 1940, later changed to the manufacture of human-food non-fat milk solids. However, they did not recondition their animal-feed equipment, but obtained new facilities instead.

** Includes a few spray units that have not operated during the past four years, although in good condition for human-food manufacture.

Available data do not always show whether the reconditioned and relocated equipment now being employed in human-food manufacture were formerly used for the processing of animal-feed buttermilk, or were merely "stand-by" equipment. The data do indicate, however, that 110 factories, which in 1940 had either "stand-by" or animal-feed equipment, have since that time reconditioned their equipment so that they were able to make human-food dried milk products. From these sources the Nation's total hourly capacity for dried milk manufacture has been increased by 24,560 pounds from the 110 roller units, and by 7,350 pounds from the spray units. (See Figure 1.)

It is unlikely that many of the milk drying units at present processing milk for animal feed can be made fit for human food manufacture without thorough factory-rebuilding. Of the reconditioned units that recently have been put into operation for human-food manufacture, many are continuing to process buttermilk, as before; only now it is for human consumption rather than for animal feed.

Altogether, these 222 factories which have reconditioned their milk drying equipment and thus converted from the manufacture of animal feed to human food, have added a total of 66,570 pounds per hour (in terms of dried non-fat milk solids) to the milk drying capacity of the United States. Some of these units were later exchanged for new ones, and some factories obtained new units in addition to the reconditioned ones they already had. (See Tables 2-a and 2-b in Appendix.)

Seventy-six Equipment Units Have Been Re-located, Most of Them After Being Factory-Rebuilt; Combined Capacity in Pounds Dried Milk per Hour of Operation, 17,940

Some of the equipment that had been used for drying milk for human consumption was no longer usable for that purpose by 1940. This was either because of its location (the available milk now being required for direct human consumption), or because of the condition of the equipment. But the scarcity of strategic materials made it necessary to re-build many of the former animal-feed units, and to re-locate them in areas where conditions assured their more efficient use.

Some of the relocated equipment has not required rebuilding. If it lacked sanitary auxiliary facilities in its old location, these were supplied in the new, and conversion to human-food use was relatively easy. But factory-rebuilding has been important, and equipment manufacturers have readily accepted old machines as part payments on new units. During the past four years 46 roller units are known to have been "traded in" (Table 5). Some of the relocated equipment originated from factories that have ceased operations since 1940. Such factories are known to have had at least 9 roller driers.

Re-location of milk drying equipment has some practical limitations: (1) It is often needed where it is, in order to process "excess milk" which would otherwise be wasted,-- even though such "excess" occurs only for a short period during the year; and (2) it is often "built-in" so that it cannot be moved. This latter situation is most often true in the case of spray equipment. A number of spray units were replaced or rebuilt during 1941 - 44, but they remained in their original location. (One spray drier was moved in 1940). There is no record of any re-location of spray drying equipment during this four-year period; but at least 76 re-located roller units (not all of them factory-rebuilt,) are known to have been placed advantageously in factories producing human-food dried milk during this same four-year period (Table 3). It is possible that there were even more. (See Figure 1, and Table 3-a in Appendix.)

Table 3. Re-located Milk Drying Equipment Installed or Planned For Since 1940 (up to August 1, 1944) *
(For Human Food Only **)

Factory group, by product manufactured during 1940	Number of units	Combined capacity, pounds dried milk per hour
Human-food dried skim-milk ***	11	2,960
Animal-feed dried skim-milk	9	1,940
Animal-feed dried buttermilk	4	1,020
New factories (No dried milk products during 1940)	52	12,020
T o t a l	76	17,940

* At the time this report was compiled a few factories had not yet completed the installation of authorized or planned for milk drying equipment.

** A number of relocated equipment units were also placed into animal-feed factories.

*** Practically none of the relocated equipment here listed was placed into factories manufacturing human-food products other than dried non-fat milk solids.

Three Hundred Nineteen New Units (113 Spray Driers and 206 Roller Driers) Have Been Placed Since 1940; Combined Capacity in Pounds Dried Milk per Hour of Operation, 134,360

The largest increases in the manufacture of dried milk for human consumption have taken place in areas relatively new in its production. New equipment had to be supplied, particularly for the 156 new factories which had never manufactured dried milk products before, and therefor had no equipment at all, not even "stand-by". (See Table 4-a in Appendix.) New equipment has been necessary in increasing amounts, as the supply of the used equipment has become exhausted. (See Table 4-a and Table 4-b in Appendix.)

To assure its most efficient use, this new equipment had to be placed in the heavy milk producing areas where there were good prospects for conversion from the sale of farm-separated cream to that of whole milk. For this reason, half of this new equipment went into Wisconsin and Minnesota, the former obtaining 89 units with a combined hourly capacity of 42,210 pounds, while Minnesota received 83 new units capable of producing 32,250 pounds of dried non-fat milk solids per hour. (See Table 4-b in Appendix.)

During these four years a total of 113 spray units was installed, although some of these replaced old units. There were also installed for human-food manufacture a total of 206 new roller units. A few new roller units have also been placed into factories manufacturing animal-feed dried buttermilk. It is possible that in time these may be converted to the manufacture of human food. (See Table 4, and Figure 1.)

Table 4. New Milk Drying Equipment Installed or Authorized Since 1940 (up to August 1, 1944) *

Factory group, by product manufactured during 1940	Spray		Roller		Total capacity dried milk per hour
	Number of units	Capacity per hour	Number of units	Capacity per hour	
Human-food dried non-fat milk solids	43	30,060	39	12,760	42,820
Human-food dried milk products other than non-fat milk solids	-	--	2	700	700
Animal-feed dried skim-milk	12	8,700	51	14,860	23,560
Animal-feed dried buttermilk (including "stand-by")	7	3,350	16	5,040	8,390
New factories (no dried milk products in 1940)	51	30,480	98	28,410	58,890
Total	113	72,590	206	61,770	134,360

* At the time this report was compiled a few factories had not yet completed the installation of authorized or planned for milk drying equipment.

The combined capacity of these 319 new equipment units which were installed since 1940 is 134,360 pounds of dried non-fat milk solids per hour of operation. Had there been no losses in equipment during these four years, the combined capacity of all the factories in the United States capable of producing human-food dried milk products would have been 372,110 pounds per hour of operation. (See Table 6, page 14.) But, of course, there were such losses.

IV. MILK DRYING CAPACITY LOSSES

Losses in the Nation's capacity for manufacturing human-food dried milk products arise from three causes:

1. Obsolescence. The equipment is worn out or destroyed.
2. Diversion. The equipment is used for the manufacture of other products.
3. Idleness. The supply of milk within reasonable distances of the equipment is utilized for other purposes.

Seventy-one Milk Drying Units Have Been Replaced Since 1940; Combined Capacity in Pounds Dried Milk per Hour of Operation, 19,110

Since 1940 a total of 13 spray-process drying units have been replaced with new units, and at least one has been dismantled. These 14 units had a combined capacity of 7,200 pounds of dried non-fat milk solids per hour of operation. There is no record of any of the old spray units having been re-located into other factories. (In 1940 one spray unit was re-located). The most of these 13 spray units were replaced by spray units of larger capacity, so that there was a net capacity gain in the replacement.

During this same period a total of 57 roller units, with a combined capacity of 11,910 pounds of dried non-fat milk solids per hour, have been "traded in", destroyed, worn out, or are located in closed factories. The "trade-in" units have been consistently re-built and re-located to do service elsewhere. (Table 5.)

Table 5. Milk Drying Equipment Destroyed, Replaced, Worn-out, and Taken Out of Factories During The Four-Year Period, 1941 - 1944, inclusive. *

	Spray		Roller		Total capacity per hour
	Number units	Capacity per hour	Number units	Capacity per hour	
Sold or "traded in"	-	--	46	10,190	10,190
Worn out or replaced	14	7,200	1	50	7,250
Destroyed by fire	-	--	1	220	220
Factories closed	-	--	9	1,450	1,450
T o t a l	14	7,200	57	11,910	19,110

* This table is based on reports sent to the Division of Dairy Statistics, BAE, on correspondence with the factories concerned, on information gathered during field trips, and other more-or-less accidental information.

It is probable that the available data on the movement of used milk drying equipment units are not quite complete. It is quite likely, therefor, that a few more than 57 roller units have been disposed of by the milk drying factories.

One Thousand and Eight Drying Units Now in Condition To Manufacture Human-Food Dried Milk Products; Combined Capacity in Pounds Dried Milk per Hour of Operation, 352,670

If we deduct the capacity of the equipment that is known to have been discarded, lost, or replaced, we find that there is still enough milk drying equipment in the United States to produce 352,670 pounds of dried non-fat milk solids per hour of operation. (See Figure 2, the graphic illustration on page 16, and Table 6, below.)

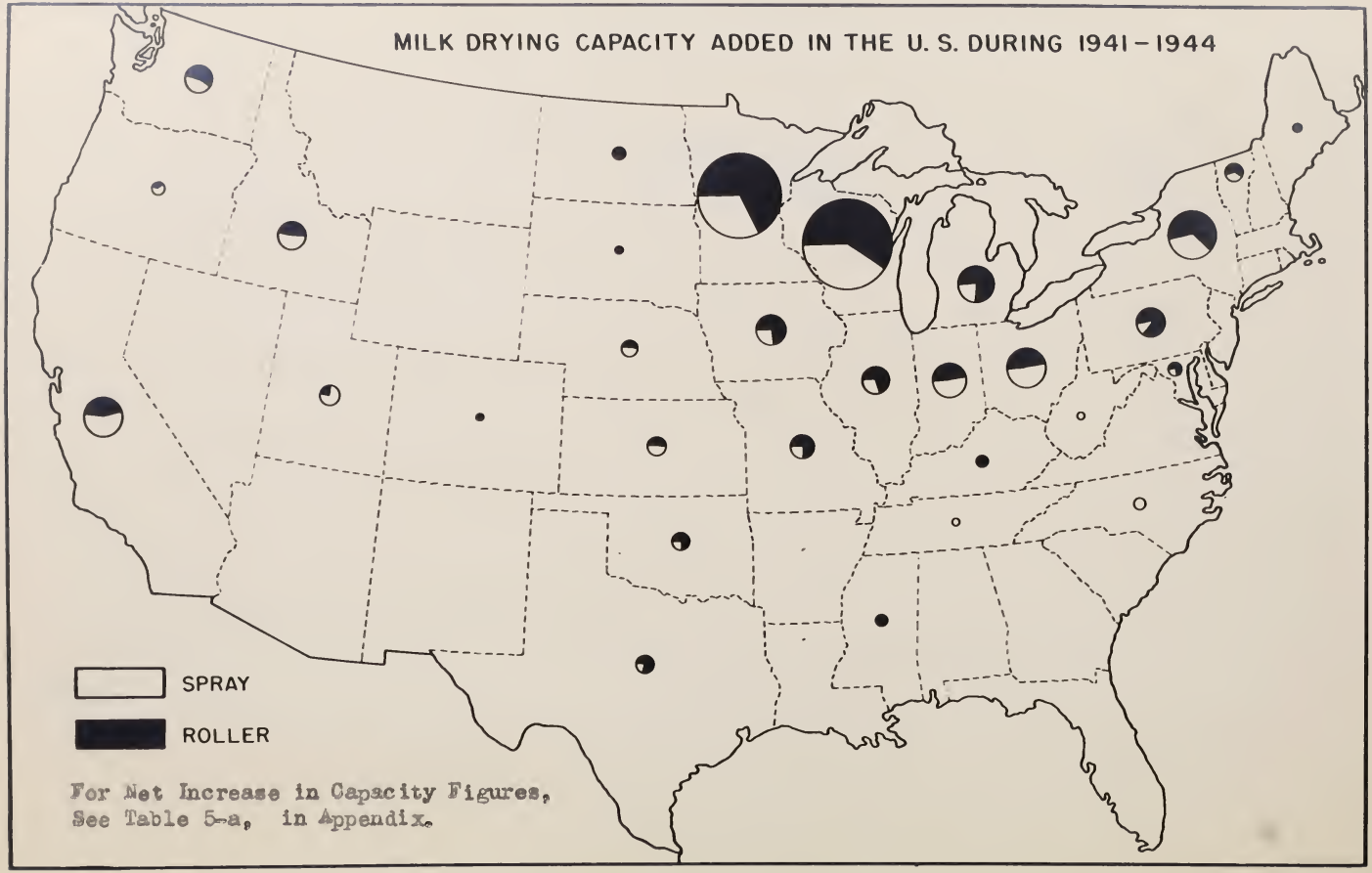
Table 6. Combined Capacity of All Spray and Roller Milk Drying Units in the United States that are Suitable for Manufacturing Dried Milk Products for Human Consumption (August, 1944).

Origin of equipment	Spray		Roller		Total capacity per hour
	Number units	Capacity per hour	Number units	Capacity per hour	
New equipment *	113	72,590	206	61,770	134,360
Re-located from other factories **	-	--	76	17,940	17,940
Re-conditioned units formerly used for animal-feed dried milk products ***	23	9,350	242	57,220	66,570
In use in 1940 for manufacture of human-food dried milk products ****	149	78,610	270	74,300	152,910
Total (Gross)	285	160,550	794	211,230	371,780
LESS:					
Discarded units *****	14	7,200	57	11,910	19,110
NET TOTAL	271	153,350	737	199,320	352,670

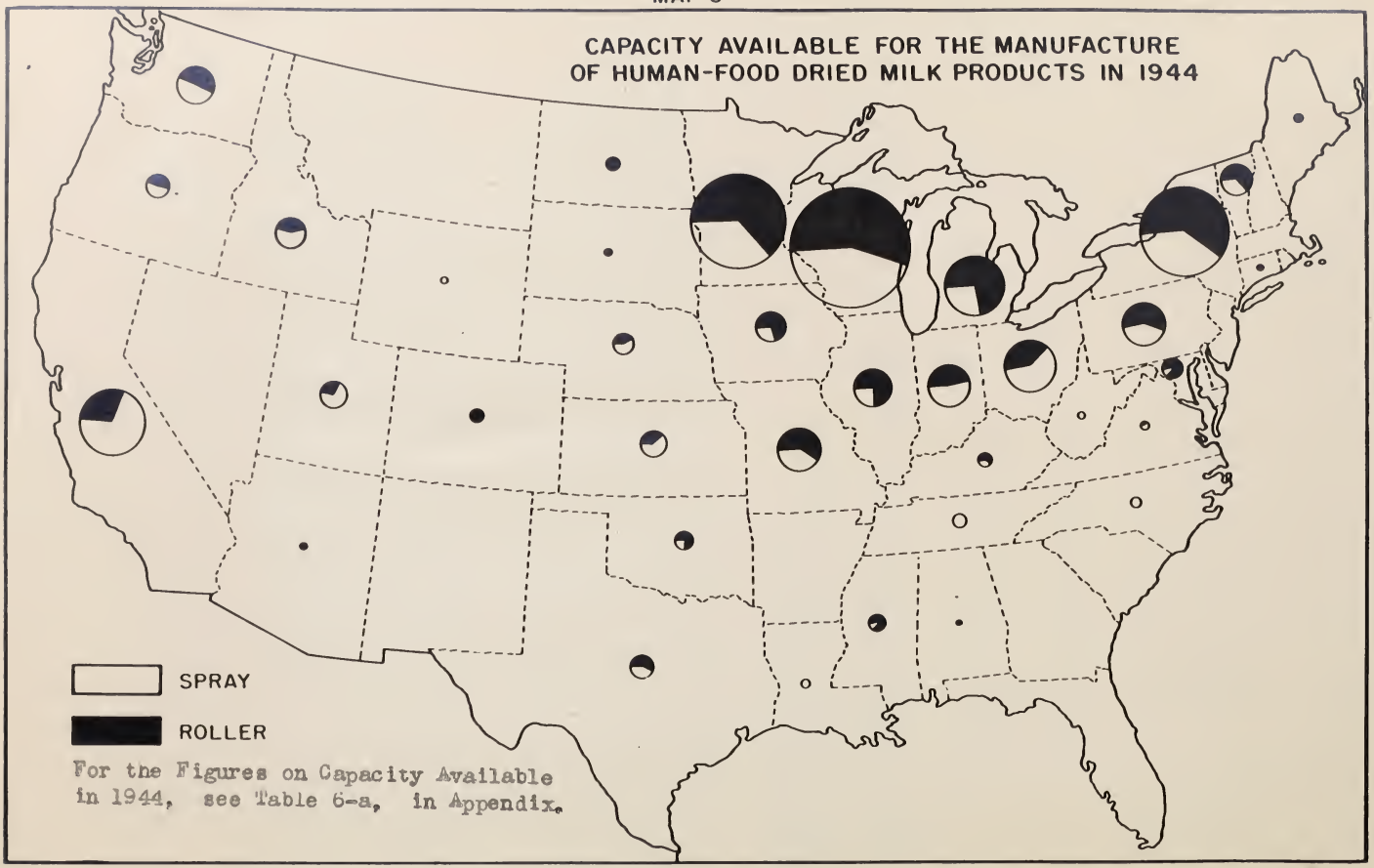
* From Table 4. ** From Table 3. *** From Table 2
**** From Table 1. ***** From Table 5.

The accompanying Map 1 and Map 2 illustrate the state-by-state increases, and the (August) 1944 state-by-state situation in regard to equipment capacity for the production of human-food dried milk products. (See also Tables 5-a and 6-a in Appendix.)

MAP 2


MILK DRYING CAPACITY ADDED IN THE U. S. DURING 1941 – 1944
SPRAY
ROLLER
For Net Increase in Capacity Figures,
See Table 5-a, in Appendix.

MAP 3


CAPACITY AVAILABLE FOR THE MANUFACTURE
OF HUMAN-FOOD DRIED MILK PRODUCTS IN 1944
SPRAY
ROLLER
For the Figures on Capacity Available
in 1944, see Table 6-a, in Appendix.

Forty-two Milk Drying Units, or More, Have Dried Eggs And Other Food Products in the Past Two Years; Combined Capacity in Pounds Dried Milk per Hour of Operation, 21,885

The war-time demand for dehydrated foods has caused a number of drying factories, originally equipped to process milk, to shift their operations, in whole or in part, into the drying of eggs and other food products. These are nearly all spray-process units. At least 42 such equipment units have dried eggs during 1942 or 1943 (or both years). Some of them dried eggs only a few days a week, or only during seasons when eggs are plentiful. Some have again ceased their egg drying operations, and once more are processing milk.

A few former milk driers are manufacturing soluble coffee and other dehydrated food products, mainly for the use of the Armed Forces and Lend-Lease shipment. It is difficult to keep informed on the activities of the many drying units now in operation, but it is certain that the capacity now being devoted to the processing of food products other than milk is sufficient to manufacture at least 23,335 pounds of dried non-fat milk solids per hour. 7/ (See Table 7.)

Milk-Drying Equipment is Being Kept in Usable Condition

The information revealed in the priority applications, and the data obtained through field investigations, indicate that:

1. Equipment is being kept in usable condition, even though it may be quite old.

2. Relatively few units are in danger of becoming useless because they are out-moded.

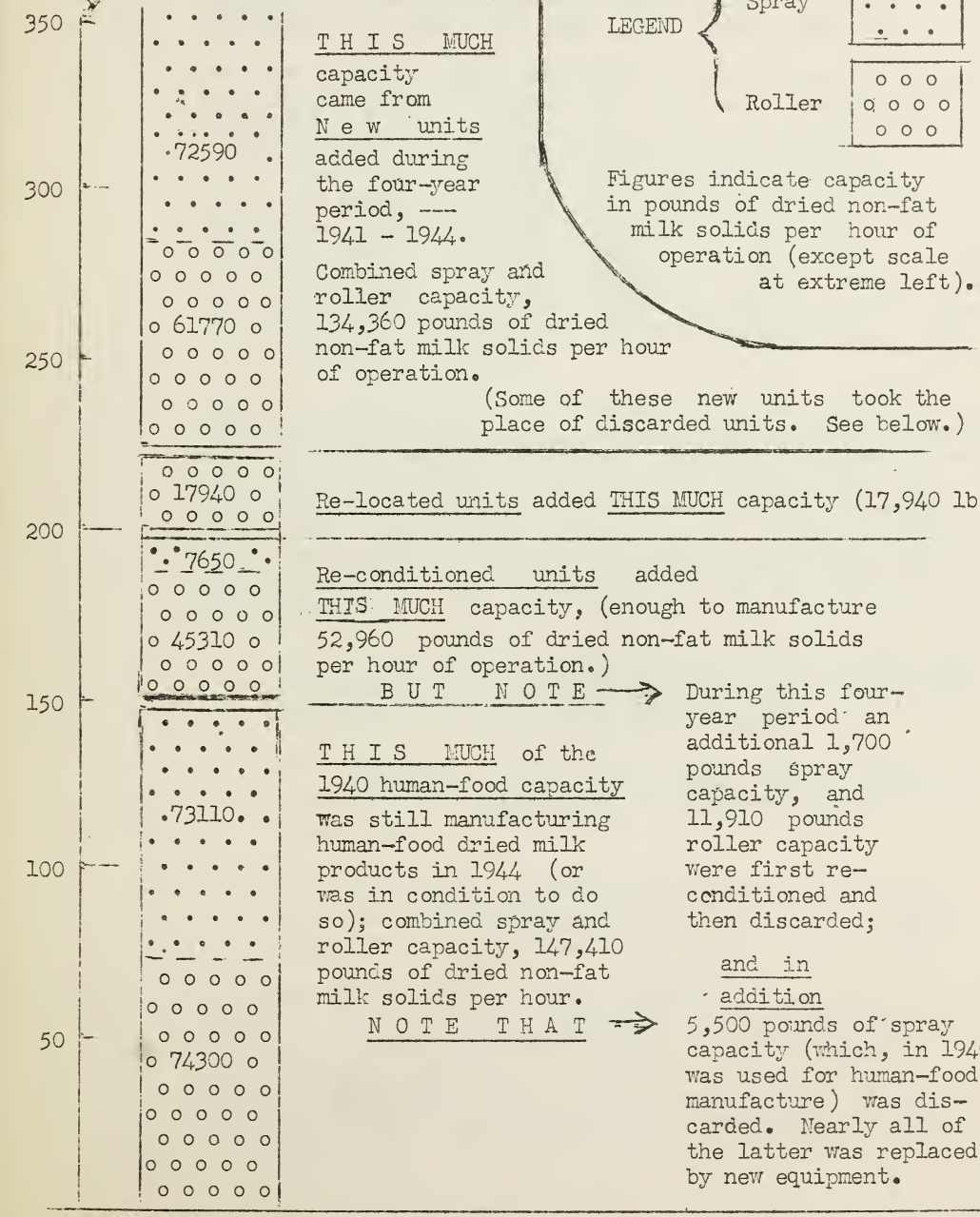
In one case a factory is reported to have obtained a roller drying unit that had been lying in a junk yard for at least two years. It was not less than 16 years old, but after a thorough re-conditioning, it was installed in a factory, and (it is claimed) it is now operating at more than its originally rated capacity!

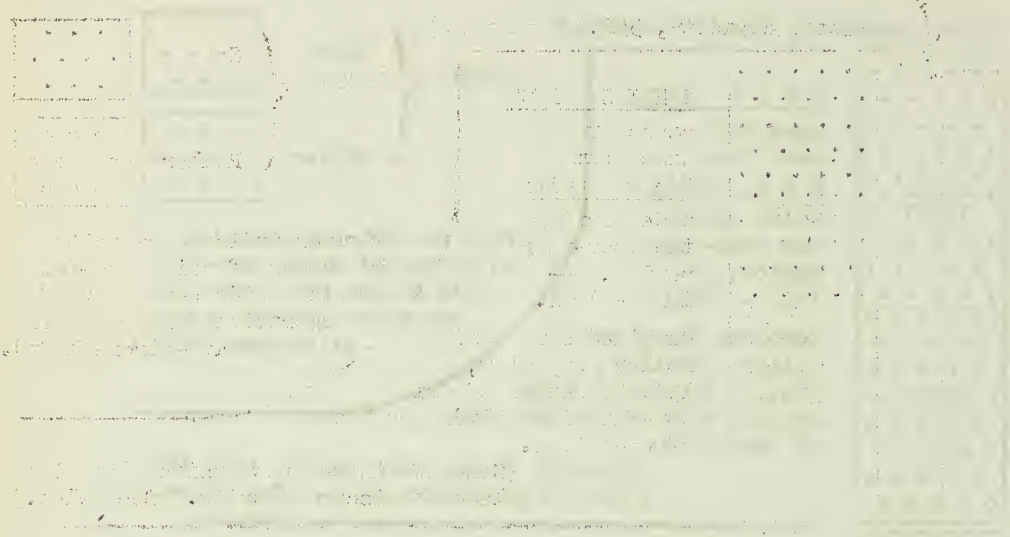
7/ In addition to these 42 units, which are known to have previously dried milk, there are about 85 other units which have dried eggs. Many of the latter do not have the auxiliary equipment necessary for handling milk, although it is quite likely that some of them have.

Capacity in thousands of pounds of dried non-fat milk solids per hour of operation

Figure 2. U. S. Milk Drying Capacity (for Human Use) in 1944

(Total capacity, 352,670 pounds.)





V. The 1944 EQUIPMENT SITUATION

Marketing and Production Developments Have Greatly Increased the Need for Spray and Roller Equipment

In order to have a clear conception of the milk drying situation as it stood in 1944, one must have an understanding of the developments that have taken place during the period from 1940 to 1944, especially as they affected the production and marketing of dried milk products. These largely unforeseen developments, in great measure due to Army and Lend-Lease demands, have put a sizeable additional burden on the Nation's dehydrating facilities. Therefor, although it is not within the compass of this report to give a detailed account of the economic forces that influence the dried milk industry, a quick review will help to explain how the Nation's spray and roller equipment is currently employed, and why.

War-time economic conditions have increased the demand for dehydrated human-food products; new developments in the field of human nutrition have made feasible the better utilization of dairy products; and, as a consequence, changes have come about in the price relationships between certain human-foods, animal feeds, and industrial raw products. This, in turn, has caused marked shifts in the utilization of, and in the market outlets for all dairy products, raw or processed, and has resulted in:

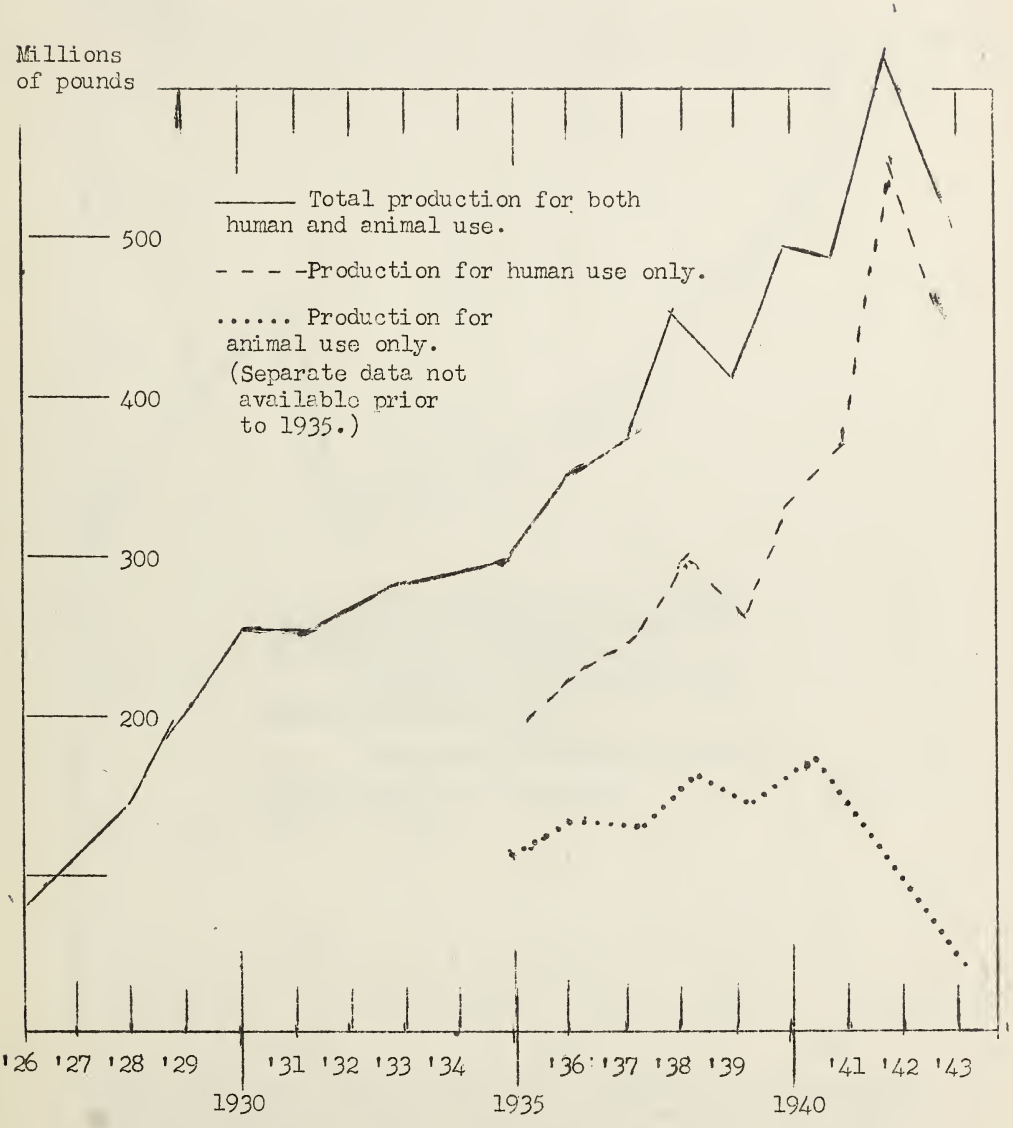
1. The utilization of increasing volumes of milk for the manufacture of dried milk products (particularly for whole-milk and non-fat milk solids).

2. The shifting of much of the milk supply formerly processed for animal-feed to the production of human food.

3. The manufacture, in increasing volumes, of many dehydrated foods other than the two standard dried-milk products (whole-milk and non-fat milk solids).

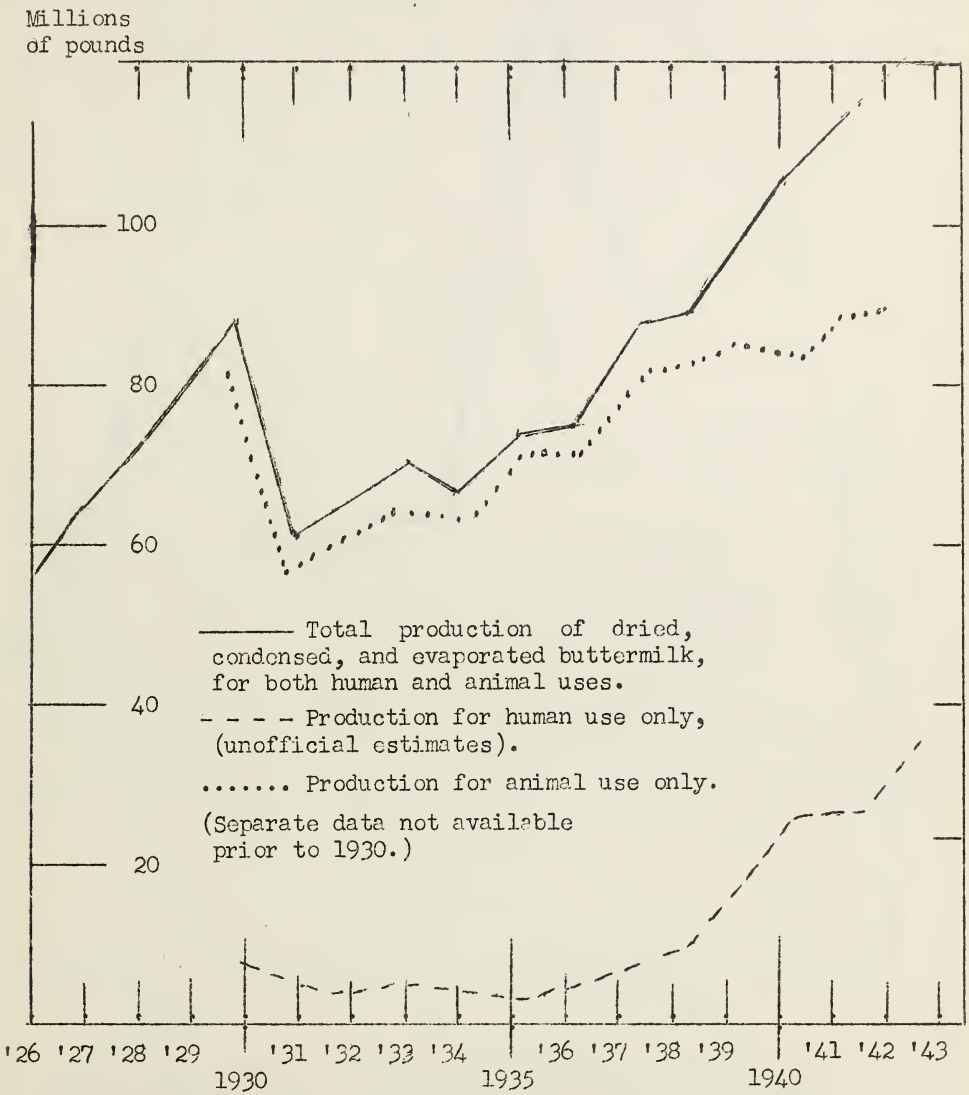
As between these food-processing developments and the need for additional spray and roller equipment, the relationship is obvious. Complete statistical data covering all phases of these production shifts are difficult to obtain; but the graphic presentations shown on the following pages, together with the explanation accompanying each, will serve to show what has happened. (See Figures 3, 4, and 5.)

Figure 3. U. S. Annual Total Dried Skim-milk Production, 1926 - 1943, inclusive.



The total volume of dried skim-milk manufactured increased annually, but the amount processed for animal feed actually decreased year by year, as more and more of the former animal-feed factories shifted to the manufacture of human food.

Figure 4. U. S. Annual Total Production of Dried, Condensed, and Evaporated Buttermilk, 1926 to 1942, inclusive. (In terms of dried buttermilk.)



During the late 'thirties and early 'forties dried buttermilk, (almost exclusively used for animal feed prior to that time,) found an expanding market in the human-food trade. Creameries receiving a good grade of cream, which required no neutralization, suddenly found strong demand for their dried buttermilk as human food. (Data on volume produced for human use are reliable only for the most recent years. See Table 8-a, in Appendix.)

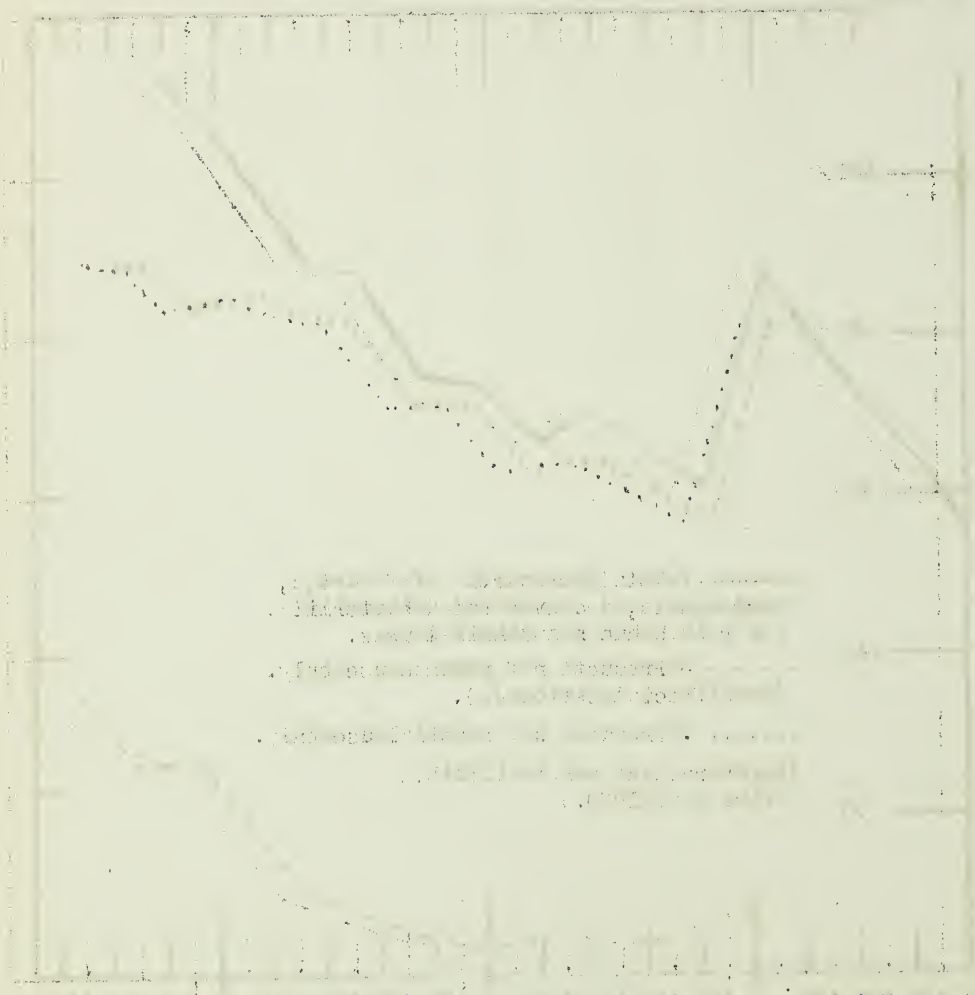
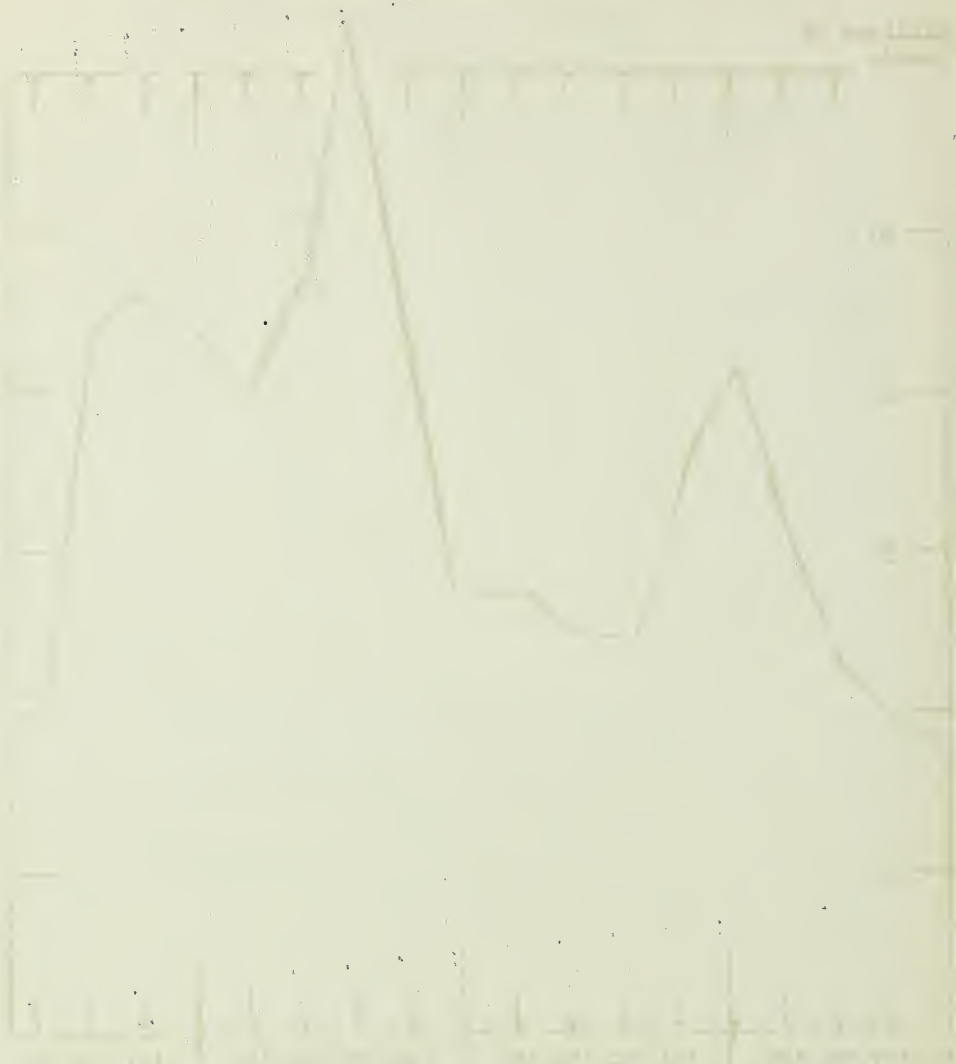


Figure 5. Volume of Dried Casein Manufactured in The United States from 1926 to 1943.

Casein production has been somewhat erratic, but shows no marked downward trend (over a period of years) until 1943. It must be kept in mind, however, that during the four-year period 1941 - 1944 milk production has increased sharply. This resulted in increased casein production in certain areas, but later these increased milk supplies were absorbed by other milk processing industries.



Recent developments in the field of nutrition (both human and animal) have revealed that whey is a valuable human food if properly treated and processed. This has created an additional demand for drying equipment. The need for other dehydrated foods for Lend-Lease shipment, and for Army and Navy Use still further increased the load on drying facilities, so that by 1944 spray and roller equipment was in use for processing a whole series of foods, not all of them milk, or even milk derivatives. By 1944 the different types of foods being processed on spray and roller equipment included, in addition to the two old standard dried milk foods (dried whole-milk and dried non-fat milk solids):

Partially skimmed milk
Chocolate milk compounds and other "milk compounds"
Whey and "whey compounds"
Cheese and "cheese compounds"
Cream and ice cream mix
Coffee extract
Eggs (both whole eggs, and whites and yolks separately)

and many other foods, as well as some non-food products, some of them of very recent development.

Since many of these products are not reported to the Department of Agriculture, there are no definite data on the amount and the capacity of the equipment used for their production. Neither do accessible data reveal exactly how much equipment is standing idle.

Available data, as of August, 1944, show that, of the facilities fully equipped with the necessary auxiliary equipment to process milk, 43 percent was spray, and 57 percent was roller. (See Table 7.) But 7 percent of the total capacity was spray equipment currently in use for drying eggs, while 6 percent (5.7 percent plus .3 percent) was spray equipment used for the manufacture of various food products other than dried whole-milk or dried non-fat milk solids, or was standing idle. (Obviously only a small number of units were idle.)

Drying equipment of the roller type was also used for manufacturing various food products other than dried whole-milk or dried non-fat milk solids, but for many of these other products roller equipment is not so readily adapted as is spray equipment. For this reason it is quite likely that a larger proportion of the roller units are idle than is the case with the spray units. That is, if roller units are not employed in milk processing, they are less likely to be put to alternative uses than are the spray units.

Table 7. 1944 Spray and Roller Capacity Available for Drying Milk (for Human Use) in the United States.

	Capacity in pounds dried milk per hour of operation	Per cent of total capacity	
Spray capacity			
Reporting human-food dried whole-milk and dried non-fat milk solids during 1944	109,040	31.0	
Reported as processing eggs during 1944	22,485	7.0	
Reported as processing other foods not derived from milk (during 1944)	850	0.3	43%
Reported as processing human-food milk products other than whole-milk or skim-milk; or not reporting during 1944 *	19,975	5.7	
Roller capacity			
Reporting human-food dried whole milk and dried non-fat milk solids during 1944	149,020	42.7	
Reporting human-food dried buttermilk only (during 1944) **	4,300	1.2	57%
Reported as processing human-food milk products other than whole-milk or skim-milk; or not reporting during 1944 *	46,160	13.1	
Total percent		100%	

* Includes a few factories not yet completed (by August, 1944), as well as some on which there is no information at the time this is written. Some of each of these may report later in the year. (But included are those definitely idle.)

** Many of the factories processing skim-milk and other milk products also manufacture some dried buttermilk for human use.

Most of the Additional Equipment was Placed in the Farm-separated Cream Area

The logical place to obtain increased supplies of human-food dried milk is, of course, where large quantities of milk are farm-separated and where the skim-milk-consuming livestock population is relatively low. In 1940, as shown by the Census data, this was in the North Central States. Some other areas offered possibilities, particularly if the milk was being wasted, or only partially used for the production of dried casein. (See Maps 1-a, 2-a, 3-a, 4-a, and 5-a, in Appendix.)

It must be kept in mind that it was necessary, even during this four-year period, to place some drying equipment in locations outside of the areas where the production of farm-separated cream was heaviest. For, in 1940, some dairy plants outside of the farm-separated cream areas were not equipped to utilize fully all of their milk for human-food purposes, particularly during the season of high production. Such dairy plants were often those whose main enterprise was the sale of fluid milk or the manufacture of whole-milk products.

The actual state-by-state net increase in milk drying equipment capacity (since 1940) is shown in Map 2. (See also Table 4-a in Appendix.) Examination of this map, together with a comparison with Maps 1-a and 2-a, in the Appendix, will reveal how closely the placement of new drying equipment coincides with the areas having the greatest potentialities for dried milk production.

Current Milk Drying Capacity (August, 1944)

Because of the many uses that have been found for drying equipment during the past four years, the milk-drying situation has become rather complex. Capacity available, in 1944 for milk-drying, state-by-state, is shown on Map 3. (See also Tables 6-a and 9-b, in Appendix.) Not all of this capacity was actually used for manufacturing dried whole-milk and dried non-fat milk solids. In the latter part of 1944 there were in existence in the United States a total of 646 factories with a combined capacity of 352,670 pounds of dried non-fat milk solids per hour of operation; but, as has already been pointed out, some of this capacity was in use for drying other products.

The state-by-state distribution of the capacity actually used by the factories which, up to July 1, 1944, had reported production of human-food dried whole-milk or dried non-fat milk solids for 1944 is shown in Table 8. (Probably more factories than shown in this table will eventually report production for 1944.)

Table 8. Equipment Capacity of Factories Reporting the Production of Dried Whole-milk and Dried Non-fat Milk Solids (for Human Use) for 1944. (Reported up to July 1.)

State	Type of factory: Roller only — Number of factories	Roller only — Capacity per hour	Combined spray & roller — Number of factories	Combined spray & roller — Capacity per hour: Spray	Combined spray & roller — Capacity per hour: Roller	Spray only — Number of factories	Spray only — Capacity per hour
Maine	1	530	-	-	-	-	-
Vermont	8	3,210	1	900	300	2	1,300
New York	32	15,875	8	7,055	3,335	8	7,050
Pennsylvania	15	3,845	1	800	330	5	2,430
Ohio	10	3,685	1	850	180	9	5,115
Indiana	9	4,220	-	-	-	7	4,900
Illinois	12	3,840	-	-	-	2	1,600
Michigan	27	10,480	4	2,420	1,270	3	2,090
Wisconsin	68	37,490	13	10,075	8,580	17	12,900
Minnesota	48	21,820	8	6,650	4,695	6	8,400
Iowa	7	2,445	1	500	200	1	350
Missouri	4	1,805	4	3,100	1,400	-	-
North Dakota	1	185	-	-	-	-	-
South Dakota	1	200	-	-	-	-	-
Nebraska	1	400	1	750	200	1	630
Kansas	1	225	2	1,300	650	3	1,230
Maryland	2	890	-	-	-	1	200
Virginia	-	-	-	-	-	1	300
West Virginia	-	-	-	-	-	1	200
Kentucky	4	695	-	-	-	1	390
Tennessee	-	-	-	-	-	1	900
Mississippi	3	805	-	-	-	-	-
Oklahoma	4	1,180	-	-	-	1	500
Texas	5	1,315	-	-	-	2	750
Idaho	3	1,525	2	1,500	890	2	1,500
Wyoming	-	-	-	-	-	1	350
Utah	2	830	1	500	800	2	750
Washington	9	2,670	-	-	-	5	3,730
Oregon	3	1,020	1	800	300	2	1,025
California	10	4,955	2	1,450	780	14	12,100
U.S. Total	290	126,140	50	38,650	23,920	98	70,720

Milk Drying Equipment was used with a High Degree of Efficiency During 1944

The many uses for which milk drying equipment was employed during 1944 make it difficult to judge the degree of efficiency with which this equipment was being used. During 1940 it was used about 6.6 hours daily , on the average, throughout the year. What about 1944? The July estimate for 1944 production of dried whole-milk and dried non-fat milk solids (combined) is 750,000,000 pounds. This will be produced (according to indications in August) by equipment having an hourly capacity of 259,430 pounds of dried non-fat milk solids. This indicates that the equipment will operate an average of 7.9 hours daily during 1944. Actually, the equipment will operate longer; for much of the various new products that have been developed since 1940 is being manufactured with the same equipment that produces the dried whole-milk and the dried non-fat milk solids.

In this connection it must be pointed out that milk-drying, because of the very nature of milk production, is a seasonal operation. In many high-producing localities the volume of milk produced in June is more than double that produced in December. If there is sufficient equipment to process the June milk by operating twenty hours daily (considered the maximum, because a "clean-up" period is necessary,) then the equipment will be used only half as many hours during the low-production period. And in the factories which process only "surplus milk" the average daily operation period must necessarily remain short; but if losses of human food are to be avoided, then such factories must be equipped with dryers.

The manufacture of dried milk products must continue to be more-or-less a seasonal operation, just as is the manufacture of butter. But it will probably be less so than it was during the 'twenties, or even during the 'thirties. (See Figure 6, on page 28.)

The "Lend-Lease" Factories

During the latter part of the four-year period 1941 - 1944 the Government, through the War Food Administration, has made special efforts to increase dried milk supplies by encouraging the building of additional dried-milk factories in suitable localities. Such factories are financed by government-sponsored agencies, and have a definite contract with the Government in which the factory agrees to deliver its product to the Government for the use of the Armed Forces, or for Lend-Lease shipment. Hence such factories are often called "Lend-Lease factories".

By August, 1944, fourteen of such "Lend-Lease" factories were in operation, and definite arrangements had been made for eleven more, most of the latter being under various stages of construction. These factories were located in Minnesota, Wisconsin, Iowa, North Dakota, and Michigan. (See Map 6-a, in Appendix.)

The fourteen factories that were in operation by August, 1944, had installed 12 spray drying units with a combined capacity of 8,650 pounds of dried non-fat milk solids per hour, and 21 roller units with a combined capacity of 5,785 pounds per hour. (See Table 9.)

Table 9. Equipment in "Lend-Lease" Milk Drying Factories. *

Number of factories	Number of months factories have operated (up to May 31, 1944)	Equipment: Spray: Number of units	Equipment: Spray: Capacity per hour	Equipment: Roller: Number of units	Equipment: Roller: Capacity per hour	Combined capacity dried milk per hour of operation
4	Over 12 months	3	2,300	9	2,560	4,860
3	6 to 12 months	1	500	6	1,575	2,075
7	Less than 6 months	8	5,850	6	1,650	7,500
14	Total	12	8,650	21	5,785	14,435

* Includes a few pieces of equipment in process of being installed, and not yet in operation. (One or two factories were obtaining additional equipment.)

Operation Efficiency of the "Lend-Lease" Factories

Since only four of these "Lend-Lease" factories have operated for a period of twelve months or more (by August, 1944), it is difficult to judge accurately the operation-efficiency of all such factories. We can, however, point out what these have done.

During the last twelve months of operation , up to and including May 31, 1944, the four factories which had operated a full year or more, had manufactured a total of 22,659,240 pounds of dried milk products. (See Table 9-a in Appendix.) This indicates that these four "Lend-Lease" factories operated, on the average, 12.8 hours daily. These factories are all four in the "farm-separated cream area", where milk production is generally high. But, since milk production is of a seasonal nature, the dried milk production of these four factories is probably near the maximum of the volume that can be hoped for. (See Figure 6, which illustrates the month-by-month production of dried milk and casein in the United States for 1942.)

Among the factors that were considered in the location of these "Lend-Lease" factories, the most important were:

1. The volume of milk produced in the prospective area.

2. The percent of milk which was sold in the form of farm-separated cream.

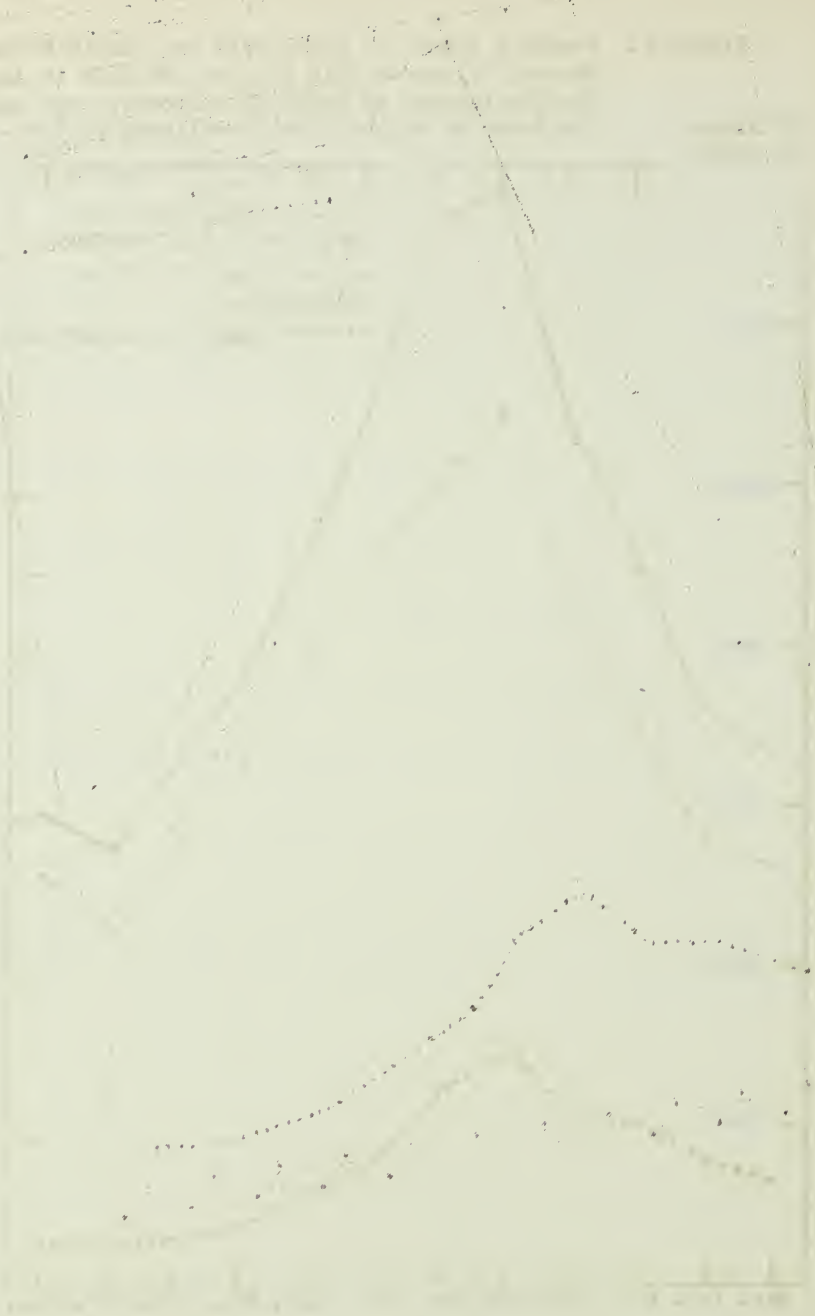
3. The proportion of the total milk production which originates in the larger herds (of ten cows or more).

4. The number of hogs in relation to the available skim-milk supply.

5. Milk and cream production trends.

Such information is readily obtained from the U. S. Census reports.

(For indices to the characteristics of the areas in which these "Lend-Lease" factories are located, see Tables 10-a and 10-b, in the Appendix.)



A P P E N D I X

Sources of Information

Supplementary Tables

M a p s .

Sources of Information

1. The 1941 and 1942 Milk-Drying Equipment Surveys conducted by the Bureau of Agricultural Economics.

2. Priority applications for new or additional equipment.

3. Field inspections and investigation reports made by members of the Dairy and Poultry Branch of the Office of Distribution.

4. Lists of sales of drying equipment, furnished by the manufacturers of this equipment.

5. Division of Dairy Statistics, Bureau of Agricultural Economics. (Published reports and unpublished records of manufactures of dairy products.)

6. Interviews and correspondence with the manufacturers of dried milk products.

7. "Who's Who in the Butter, Cheese, and Milk Industries", a publication annually issued by Urner-Barry Co., 173 Chambers St., New York, N.Y. (American Butter Review No. 13.)

8. Production records in the Office of the Administrator, W.F.A. Orders Numbers 54 and 93.

9. The lists of spray and roller milk drying equipment and its locations, as compiled in 1943 by the Dairy & Poultry Branch (O.D., W.F.A.) in 1943 and revised in January, 1944.

Information was obtained on a total of 658 factories, each of which had either reported the production of human-food dried milk products during all or part of this four-year period; or which, during 1944, were in process of installing such equipment.

For 387 factories the information was obtained mainly from the 1941 and 1942 Equipment Surveys.

For 129 factories it was obtained through priority applications.

For 27 factories it was obtained from the sales lists furnished by the manufacturers of equipment.

For 31 factories it was obtained from reports on field inspections made by staff members of the Dairy & Poultry Branch.

For 26 factories it was obtained through correspondence with the management of the dried milk factory concerned.

For 58 factories the information was rather sketchy, and is based mainly on production records.

Basic information was also obtained from the U.S. Census for Agriculture for 1930 and for 1940, and and from reports published by the individual states thru their "Department of Agriculture and Markets" or similar divisions of state government.

Table 1-a Dried Milk Capacity of Spray and Roller Equipment In Use in 1940 in the Factories Reporting the Manufacture of Human-Food Dried Skim-milk. Shown By States, and by Type of Equipment.

Number of factories	State	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
1	Maine	-	-	1	150	150
8	Vermont	3	1,400	8	2,460	3,860
1	Connecticut	-	-	1	150	150
42	New York	28	13,430	53	17,965	31,395
13	Pennsylvania	8	3,730	8	1,540	5,270
12	Ohio	7	3,010	6	1,400	4,410
7	Indiana	3	1,500	6	1,810	3,310
9	Illinois	1	600	8	1,780	2,380
31	Michigan	7	3,960	38	8,725	12,685
54	* Wisconsin	28	15,500	59	16,970	32,470
14	* Minnesota	9	5,300	15	4,275	9,575
7	Missouri	5	3,100	11	3,200	6,300
2	Nebraska	2	630	1	200	830
5	Kansas	4	1,420	2	320	1,740
3	Maryland	-	-	6	1,600	1,600
2	Virginia	1	330	1	260	590
2	Kentucky	1	390	1	100	490
1	Tennessee	2	900	-	-	900
1	Alabama	-	-	1	80	80
4	Mississippi	1	200	3	710	910
1	Louisiana	1	450	-	-	450
1	Oklahoma	-	-	1	150	150
6	Texas	4	1,250	2	500	1,750
3	Idaho	2	900	1	150	1,050
1	Wyoming	1	350	-	-	350
1	Colorado	-	-	2	800	800
1	Arizona	-	-	1	160	160
5	Utah	2	850	3	630	1,480
9	Washington	4	1,630	5	1,340	2,970
5	Oregon	2	1,030	4	1,250	2,280
19	California	18	13,000	12	3,410	16,410
271	U.S.Total	144	74,860	260	72,085	146,945

* Due to misinterpretation of the information-request form sent out for 1940, by the Division of Dairy Statistics, B.A.E., one Minnesota and one Wisconsin factory each reported the manufacture of dried skim-milk, when actually this was not the case.

Table 1-b. Dried Milk Capacity of Spray and Roller Equipment in Use in 1940 for the Manufacture of Human-Food Dried Milk Products Other Than Dried Skim-Milk. Shown by States and by Type of Equipment.

Number of factories	State	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
1	New York	-	---	1	230	230
2	Ohio	2	1,500	1	140	1,640
1	Illinois	-	---	1	400	400
1	Michigan	-	---	3	560	560
4	Wisconsin	3	2,250	4	885	3,135
9	United States	5	3,750	10	2,215	5,965

United States Total Dried Milk Capacity of Spray and Roller Equipment Used in 1940 for the Manufacture of ALL Human-Food Dried Milk Products. (Totals of Tables 1-a and 1-b.)

Number of factories	Product Manufactured	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
271	Dried skim-milk	144	74,860	260	72,085	146,945
9	Other than skim-milk	5	3,750	10	2,215	5,965
280	T o t a l	149	78,610	270	74,300	152,910

Total number of equipment units, 419.

Table 2-a. Dried Milk Capacity of Spray and Roller Equipment Used in 1940 for Animal-Feed Skim-milk Manufacture, But Later Re-conditioned and Used for Human-Food Dried Milk Manufacture. Shown by States and Type of Equipment.

Number of factories	State	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
2	Vermont	-	-	3	1,000	1,000
16	New York	-	-	22	6,000	6,000
2 *	Pennsylvania	-	-	2	500	500
6	Ohio	-	-	6	1,320	1,320
3	Indiana	-	-	3	580	580
2	Illinois	-	-	2	480	480
10 *	Michigan	-	-	11	2,550	2,550
35	Wisconsin	1	190	45	10,860	11,050
15	Minnesota	-	-	17	4,480	4,480
1	Iowa	-	-	1	200	200
1	Missouri	1	400	1	190	590
1	Kansas	1	210	-	-	210
2	Maryland	-	-	2	430	430
1	Kentucky	-	-	1	230	230
1	Texas	-	-	1	500	500
2 *	Idaho	-	-	2	450	450
5	Washington	2	1,200	4	970	2,170
2	Oregon	-	-	2	420	420
5 *	California	-	-	6	1,500	1,500
112	U.S. total	5	2,000	131	32,660	34,660

* In addition to the factories here listed, the States marked * had at least one more factory which was manufacturing animal-feed dried skim-milk in 1940, and which later changed to the manufacture of human-food dried milk products. However, when these latter factories began manufacturing human-food dried milk they did not re-condition their animal-feed equipment, but obtained other equipment instead. (This was also the case in one Mississippi factory not listed above.)

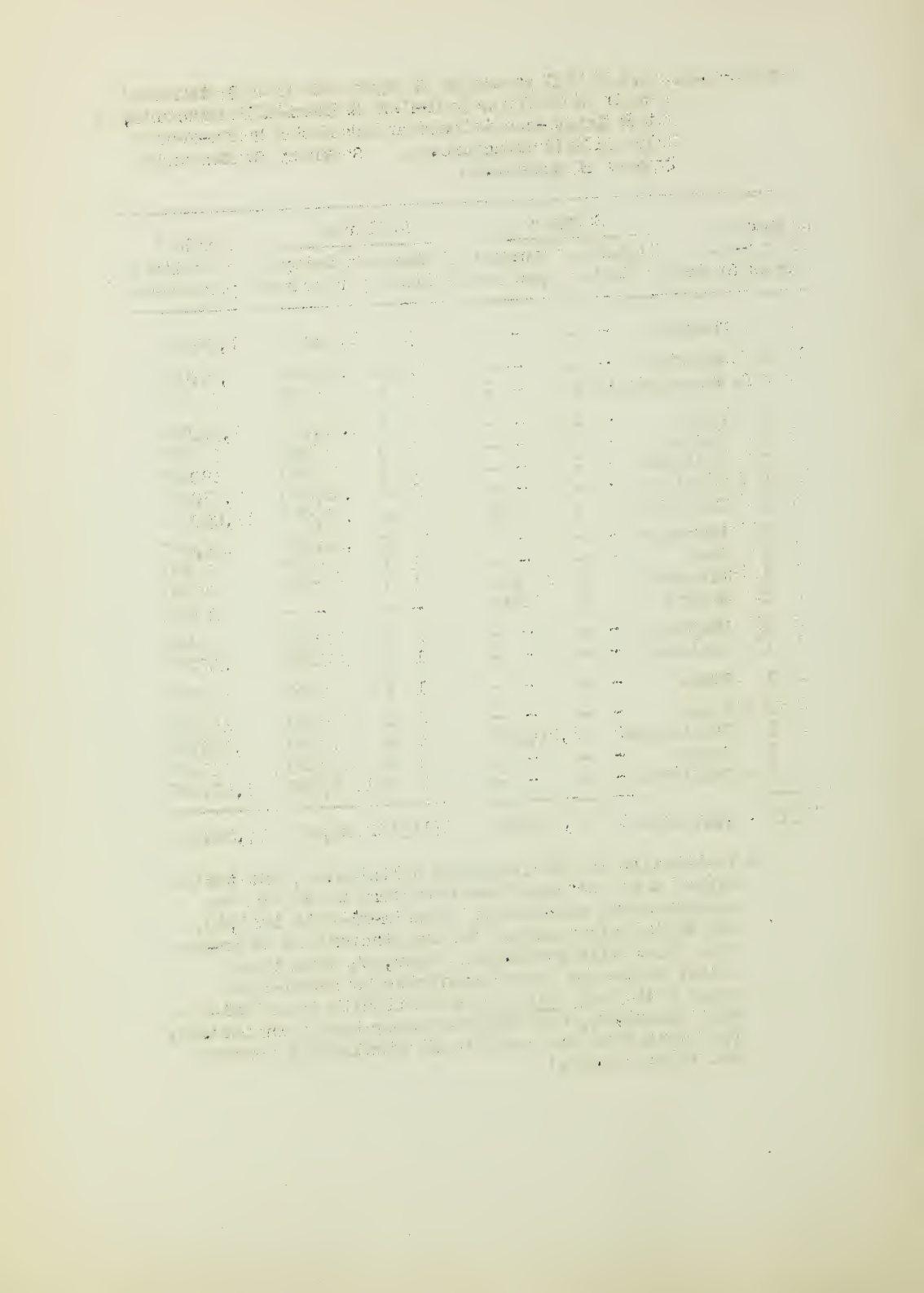


Table 2-b. Dried Milk Capacity of Spray and Roller Equipment Used in 1940 for Animal-Feed Buttermilk, or as "Stand-by Facilities", but later Re-conditioned And Used for Human-Food Dried Milk Manufacture. Shown by States and Type of Equipment.

Number of factories	State	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
10	New York	2	800	8	2,200	3,000
10	Pennsylvania	-	-	12	2,870	2,870
10	Ohio	3	1,500	7	1,560	3,060
4	Indiana	1	600	4	1,270	1,870
4	Illinois	2	550	2	630	1,180
9	Michigan	-	-	9	1,720	1,720
17	Wisconsin	1	400	17	3,460	3,860
12	Minnesota	1	450	23	4,280	4,730
3	Iowa	-	-	3	890	890
3	Missouri	-	-	3	780	780
2	South Dakota	-	-	2	400	400
2	Nebraska	-	-	2	660	660
2	Kansas	-	-	2	460	460
1	West Virginia	-	-	1	50	50
2	Kentucky	-	-	2	380	380
1	Mississippi	-	-	1	230	230
2	Oklahoma	-	-	2	420	420
6	Texas	1	400	4	920	1,320
1	Idaho	-	-	1	190	190
1	Colorado	-	-	1	200	200
3	Utah	3	950	1	250	1,200
1	Washington	-	-	1	140	140
5	California	4	1,700	2	600	2,300
110	U.S. total	18	7,350	111	24,560	31,910

Table 3-a. Re-located Milk Drying Equipment Installed During 1941 - 1944, by States.

State	Number of units	Total capacity per hour
Vermont	1	350 lbs. dried milk
New York	7	1,670 " " "
Indiana	1	220 " " "
Michigan	1	230 " " "
Wisconsin	19	4,750 " " "
Minnesota	32	7,360 " " "
Iowa	1	230 " " "
Missouri	2	500 " " "
North Dakota	3	590 " " "
Mississippi	1	180 " " "
Oklahoma	2	520 " " "
Washington	2	400 " " "
California	4	940 " " "
U. S. Total	76	17,940 " " "
By years		
Year		
1941	10	2,330 lbs. dried milk
1942	21	5,340 " " "
1943	21	4,860 " " "
1944	24	5,410 " " "
By type of factory		
The factories which, during 1940, manufactured:		
Human-food dried milk	11	2,960 " " "
Animal-feed skim-milk	9	1,940 " " "
Animal-feed buttermilk	* 4	1,020 " " "
New factories (No dried milk products manufactured prior to 1941)	52	12,020 " " "

* Includes factories which had "stand-by" units in 1940.

Table 4-a. Number and Capacity of New Milk Drying Units Installed or Planned for Since 1940, by Years, with Factories Grouped according to 1940 Production Status.

Year	Factory group *	Spray		Roller		Total capacity per hour
		Number units	Capacity per hour	Number units	Capacity per hour	
1941	Human	7	3,680	4	1,240	4,920
	Animal	-	--	6	1,620	1,620
	Buttermilk	1	400	-	--	400
	New	5	2,580	11	2,870	5,450
	1941 total	13	6,660	21	5,730	12,490
1942	Human	14	8,600	13	4,210	12,810
	Animal	6	5,350	17	4,800	10,250
	Buttermilk	2	650	3	940	1,590
	New	13	7,900	15	4,550	12,450
	1942 total	35	22,500	48	14,500	37,000
1943	Human	11	7,330	11	3,720	11,050
	Animal	2	1,000	19	5,450	6,450
	Buttermilk	4	2,300	1	260	2,560
	New	17	11,400	29	8,490	19,890
	1943 total	34	22,030	60	17,920	39,950
1944	Human	11	10,450	13	4,290	14,740
	Animal	4	2,350	9	2,990	5,340
	Buttermilk	-	--	12	3,840	3,840
	New	16	8,600	43	12,500	21,100
	1944 total	31	21,400	77	23,620	45,020
Four-year total		113	72,590	206	61,770	134,360
	Human	43	30,060	41	13,460	43,520
	Animal	12	8,700	51	14,860	23,560
	Buttermilk	7	3,350	16	5.040	8,390
	New factories	41	30,480	98	28,410	58,890

* "Human" factories are those which, in 1940, were manufacturing human-food dried skim-milk or dried whole-milk.

"Animal" factories are those which, in 1940, were manufacturing dried skim-milk for animal feed only.

"Buttermilk" factories are those which, in 1940, were manufacturing dried buttermilk for animal feed only (including the factories in which the equipment was "stand-by" during that year.)

"N e w" factories are those which have started the manufacture of dried milk products since 1940.

Table 4-b. Number and Capacity of New Spray and Roller Milk Drying Equipment Units Installed in the United States Since 1940; by Year, and by States. *

Four-year total					1941				1942				1943				1944			
Spray		Roller			Spray		Roller		Spray		Roller		Spray		Roller		Spray		Roller	
Number of units	Capacity per hr.	Number of units	Capacity per hr.	STATE	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.	Number of units	Capacity per hr.
0	0	1	380	Maine	0	0	0	0	0	0	1	380	0	0	0	0	0	0	0	0
1	800	1	220	Vermont	1	800	0	0	0	0	0	0	0	0	0	0	0	0	1	220
10	4980	6	2190	New York	1	180	2	760	4	1600	1	400	4	2500	0	0	1	700	3	1030
2	700	5	1530	Pennsylvania	0	0	0	0	2	700	2	570	0	0	1	380	0	0	2	580
5	3250	6	1850	Ohio	0	0	0	0	1	850	2	640	4	2400	2	630	0	0	2	580
7	4300	6	2160	Indiana	0	0	1	400	3	1700	3	1000	2	1200	2	760	2	1400	0	0
1	750	6	2170	Illinois	0	0	0	0	0	0	3	970	1	750	1	400	0	0	2	800
4	1850	10	3190	Michigan	0	0	2	370	0	0	3	1080	1	350	2	580	3	1500	3	1160
30	23980	59	18230	Wisconsin	2	1100	4	1280	11	9800	17	5020	11	8030	25	7530	6	5050	13	4400
25	15550	58	16700	Minnesota	3	1350	9	2160	7	4050	8	2320	4	2900	13	3860	11	7250	28	8360
3	1550	12	2950	Iowa	0	0	1	230	1	500	1	150	1	350	5	1150	1	700	5	1420
3	2200	4	1400	Missouri	0	0	0	0	1	500	1	400	0	0	2	600	2	1700	1	400
0	0	2	460	North Dakota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	460
1	750	1	200	Nebraska	0	0	0	0	1	750	1	200	0	0	0	0	0	0	0	0
2	1200	3	810	Kansas	0	0	0	0	1	500	1	200	0	0	0	0	1	700	2	590
1	200	0	0	West Virginia	0	0	0	0	1	200	0	0	0	0	0	0	0	0	0	0
1	200	1	330	Maryland	1	200	0	0	0	0	0	0	0	0	0	0	0	0	1	330
1	650	0	0	North Carolina	1	650	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	230	Mississippi	0	0	0	0	0	0	0	0	0	0	1	230	0	0	0	0
1	230	0	0	Tennessee	1	230	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	500	2	700	Oklahoma	0	0	0	0	1	500	0	0	0	0	1	300	0	0	1	400
0	0	2	410	Texas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	410
5	2500	6	1780	Idaho	1	500	0	0	0	0	2	590	3	1500	1	230	1	500	3	960
3	1200	1	380	Utah	0	0	0	0	0	0	0	0	1	200	1	380	2	1000	0	0
1	900	4	1020	Washington	0	0	1	230	0	0	0	0	0	0	0	0	1	900	3	790
1	800	0	0	Oregon	1	800	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	3550	9	2480	California	1	850	1	300	1	850	2	560	2	1850	3	890	0	0	3	730
113	72590	206	61770	U. S. Total	13	6660	21	5730	35	22500	48	14500	34	22030	60	17920	31	21400	77	23620

* In addition to the new units shown in this table, a few more were placed in factories producing products other than human-food dried milk. (Animal-feed dried buttermilk, etc.)

Table 5-a. Net Increase in Human-food Milk Drying Capacity During Four-Year Period 1941 - 1944, inclusive (up to August, 1944). By States and Type of Equipment. *

State	Capacity in pounds of dried milk, per hour of operation		
	Spray	Roller	Combined Spray & Roller
Maine	-	380	380
Vermont	800	1,570	2,370
New York	5,080	10,805	15,885
Pennsylvania	700	4,875	5,485
Ohio	4,750	4,590	9,340
Indiana	4,200	4,000	8,200
Illinois	1,300	3,110	4,410
Michigan	1,850	6,420	8,270
Wisconsin	21,770	32,045	53,815
Minnesota	15,000	31,400	46,400
Iowa	1,550	4,270	5,820
Missouri	900	2,870	3,770
North Dakota	-	1,050	1,050
South Dakota	-	400	400
Nebraska	750	860	1,610
Kansas	1,110	1,270	2,380
Maryland	200	620	820
West Virginia	200	-	200
North Carolina	650	-	650
Kentucky	-	610	610
Tennessee	230	-	230
Mississippi	-	640	640
Texas	400	1,690	2,090
Oklahoma	500	1,450	1,950
Colorado	-	400	400
Idaho	2,500	2,270	4,770
Utah	2,150	630	2,780
Washington	2,100	2,395	4,495
Oregon	800	420	1,220
California	5,250	4,270	9,520
U. S. Total	74,740	125,020	199,760

* Includes a few units not yet installed at this date (but definitely planned for.)

Table 6-a. Capacity of Spray and Roller Equipment Available in 1944 for the Manufacture of Human-Food Dried Milk Products; by States.

Number of factories	State	Capacity in pounds of dried non-fat milk solids per hour of operation		
		Spray	Roller	Combined spray & roller
1	Maine	--	530	530
13	Vermont	2,200	4,030	6,230
1	Connecticut	--	150	150
72	New York	18,510	29,000	47,510
32	Pennsylvania	4,430	6,325	10,755
36	Ohio	9,260	6,130	15,390
22	Indiana	5,700	5,810	11,510
20	Illinois	1,900	5,290	7,190
58	Michigan	5,810	15,705	21,515
129	Wisconsin	39,520	49,900	89,420
89	Minnesota	20,300	35,675	55,975
15	Iowa	1,550	4,270	5,820
13	Missouri	4,000	6,070	10,070
3	North Dakota	--	1,050	1,050
2	South Dakota	--	400	400
5	Nebraska	1,380	1,060	2,440
9	Kansas	2,530	1,590	4,120
6	Maryland	200	2,220	2,420
1	West Virginia	200	--	200
2	Virginia	330	260	590
1	North Carolina	650	--	650
5	Kentucky	390	710	1,100
2	Tennessee	1,130	--	1,130
7	Mississippi	200	1,350	1,550
1	Alabama	--	80	80
1	Louisiana	450	--	450
14	Texas	1,650	2,190	3,840
7	Oklahoma	500	1,600	2,100
1	Wyoming	350	--	350
2	Colorado	--	1,000	1,000
9	Utah	3,000	1,260	4,260
1	Arizona	--	160	160
8	Idaho	3,400	2,420	5,820
19	Washington	3,730	3,735	7,465
7	Oregon	1,830	1,670	3,500
34	California	18,250	7,680	25,930
648	U. S. Total	153,350	199,320	352,670

NOTE: This table was compiled before the close of 1944, and there were still in prospect several changes that may be completed before the end of the year.

Table 7-a. Total Volume of Dried Skim-milk Manufactured Annually in the United States, 1920 - 1943. *

Year	Dried skim-milk production (in thousands of pounds) Human	Animal	Total	Percentage of total milk production utilized for manufacture of dried skim-milk **
1920			41,893	.73
1921			38,546	.65
1922	(Separate		40,617	.66
1923	data for		62,251	.98
1924	human and animal		69,219	1.02
1925	uses not		73,317	1.07
1926	available		91,718	1.30
1927	prior to		118,123	1.64
1928	1935.)		147,996	2.04
1929			207,579	2.77
1930			260,675	3.44
1931			261,938	3.36
1932			270,194	3.44
1933			288,114	3.63
1934			295,953	3.83
1935	187,531	109,975	297,501	3.87
1936	223,827	125,723	349,550	4.47
1937	244,511	127,692	372,203	4.76
1938	289,121	160,178	449,299	5.53
1939	267,860	140,520	408,380	4.97
1940	321,843	159,662	481,505	5.72
1941	366,455	110,042	476,497	5.45
1942	565,414	61,148	626,562	6.94
1943	454,704	24,207	478,911 ***	5.35

* From statistical data published by the Bureau of Agricultural Economics.

** Calculated on the basis of total milk production figures and dried skim-milk production figures, as published by the United States Department of Agriculture.

*** In 1943 much milk was utilized for the production of newly-developed dried dairy products, variously known under their respective trade names, and sometimes classified as "part-skim". Rightfully these should be added to the total amount of milk processed, but their exact volume in not known.

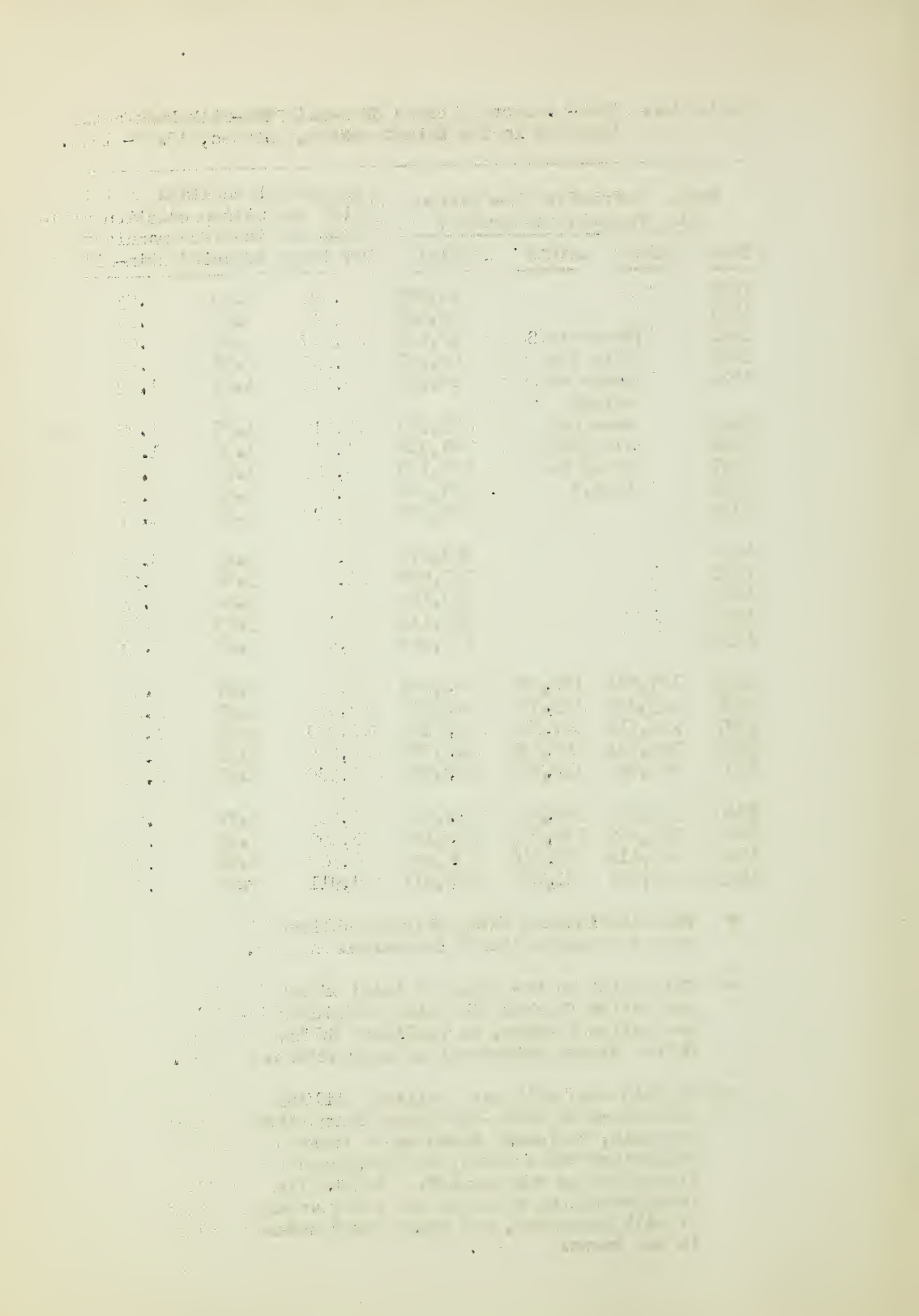


Table 8-a. Volume of Dried, Condensed, and Evaporated Buttermilk and of Casein Manufactured in the United States, 1920-1943, inclusive (in thousands of pounds).

Year	Condensed and evaporated buttermilk (dried buttermilk equivalent)	Production of dried buttermilk		Total buttermilk production in terms of dried buttermilk (dried plus condensed)	Dried casein production
		Human *	Animal **		
1920	8,794		5,704	14,498	11,526
1921	7,923	(No	7,708	15,631	8,076
1922	11,985	esti-	9,007	20,992	6,927
1923	14,820	mates	13,032	27,852	14,548
1924	18,064	avail-	18,058	36,122	20,759
1925	20,832	able prior	20,246	41,078	16,660
1926	23,429	to	31,378	54,807	16,953
1927	26,805	1930)	38,435	65,240	18,033
1928	27,690		45,502	73,192	22,151
1929	29,000		54,215	83,215	30,537
1930	26,062	5,000	59,601	90,663	41,965
1931	17,465	3,000	47,535	68,000	35,335
1932	14,099	2,000	46,712	62,811	24,428
1933	13,561	2,000	51,260	66,821	24,087
1934	17,746	3,000	50,636	71,382	37,331
1935	19,066	2,000	47,823	68,889	37,638
1936	24,212	2,000	48,781	74,993	67,467
1937	23,745	3,000	50,141	76,886	67,467
1938	24,184	6,000	57,910	88,094	48,549
1939	28,186	11,000	51,187	90,373	40,878
1940	34,951	19,000	58,614	102,882	46,616
1941	34,644	25,000	50,614	110,258	47,346
1942	45,943	25,000	44,637	115,580	42,268
1943	--	30,000	59,056	--	20,990

* Unofficial estimates only. These figures indicate the trend, but are quite unreliable until the more recent years (from about 1938 until the present).

** Total production as given in reports published by the Bureau of Agricultural Economics, minus the unofficially estimated production of human-food dried buttermilk.

Table 9-a. Production Record of "Lend-Lease" Milk Drying Factories. *

Number of factories	Number of months factories have been in operation (up to May 31, 1944)	Total production to date, (May 31, 1944,) in pounds	Pounds of dried milk produced last 12 months of operation	Annual production estimate, as stated in contract (lbs. dried non-fat milk solids)
4	12 or over	30,691,922	22,659,240 **	14,600,000
3	6 to 12	1,631,600	--	5,700,000
7	Less than 6	6,939,300	--	24,000,000

* From unpublished data in the Dairy Products Division, Dairy & Poultry Branch, W.F.A.

** Includes 728,942 pounds of dried buttermilk, and 425,170 pounds of dried whole-milk. (The remainder was dried non-fat milk solids.)

Table 9-b. Number of Factories Equipped to Manufacture Human-Food Dried Milk Products (August, 1944).

	Number
Factories that were manufacturing human-food dried milk in 1940	280
Animal-feed factories that have converted to human-food manufacture since 1940 *	222
N E W factories, beginning the manufacture of dried milk products since 1940	156
T o t a l	658
Factories that have ceased operating since 1940,	10
Net number of factories	648

* Includes the factories with "stand-by" units.

Table 10-a. Milk Production Data for the Counties Served by Lend-Lease Factories. (Based on 1940 U. S. Census.)

State and County	Milk Production: Average per acre farm land, pounds annually	Milk Production: Percent sold as "cream sold as butterfat"	Cream sold as butterfat: Percent produced in herds of 10 or more cows	Cream sold as butterfat: Average lbs. B. F. sold annually per acre farm land
Minnesota				
* Aitkin	247	84	49	8.1
Becker	196	82	53	6.2
* Carlton	310	59	45	7.1
Carver	670	56	93	14.5
* Clearwater	177	82	42	5.4
Crow Wing	195	66	57	5.0
Douglas	292	90	69	10.0
Itasca	195	65	30	4.8
* Mahnomen	149	86	61	5.0
Meeker	327	91	77	11.9
Mille Lacs	408	87	65	13.8
Otter Tail	254	88	63	8.7
Polk	126	71	50	3.4
St. Louis	226	38	22	3.3
Scott	418	41	79	6.6
Sibley	325	87	78	10.9
Todd	337	87	71	11.4
Wisconsin				
Columbia	367	24	71	3.5
Juneau	279	78	72	8.4
Monroe	414	69	88	11.1
Trempealeau	378	72	86	10.6
* Vernon	465	48	87	8.6
I o w a				
* Calhoun	127	72	22	3.5
Emmet	174	78	56	5.3
O'Brien	157	81	43	4.4
Osceola	176	78	44	5.4
Palo Alto	162	84	52	5.2
Sac	122	75	28	3.5
Michigan				
Berrien	188	21	17	1.6
* Cass	181	68	25	4.7
North Dakota				
Traill	68	74	45	1.9

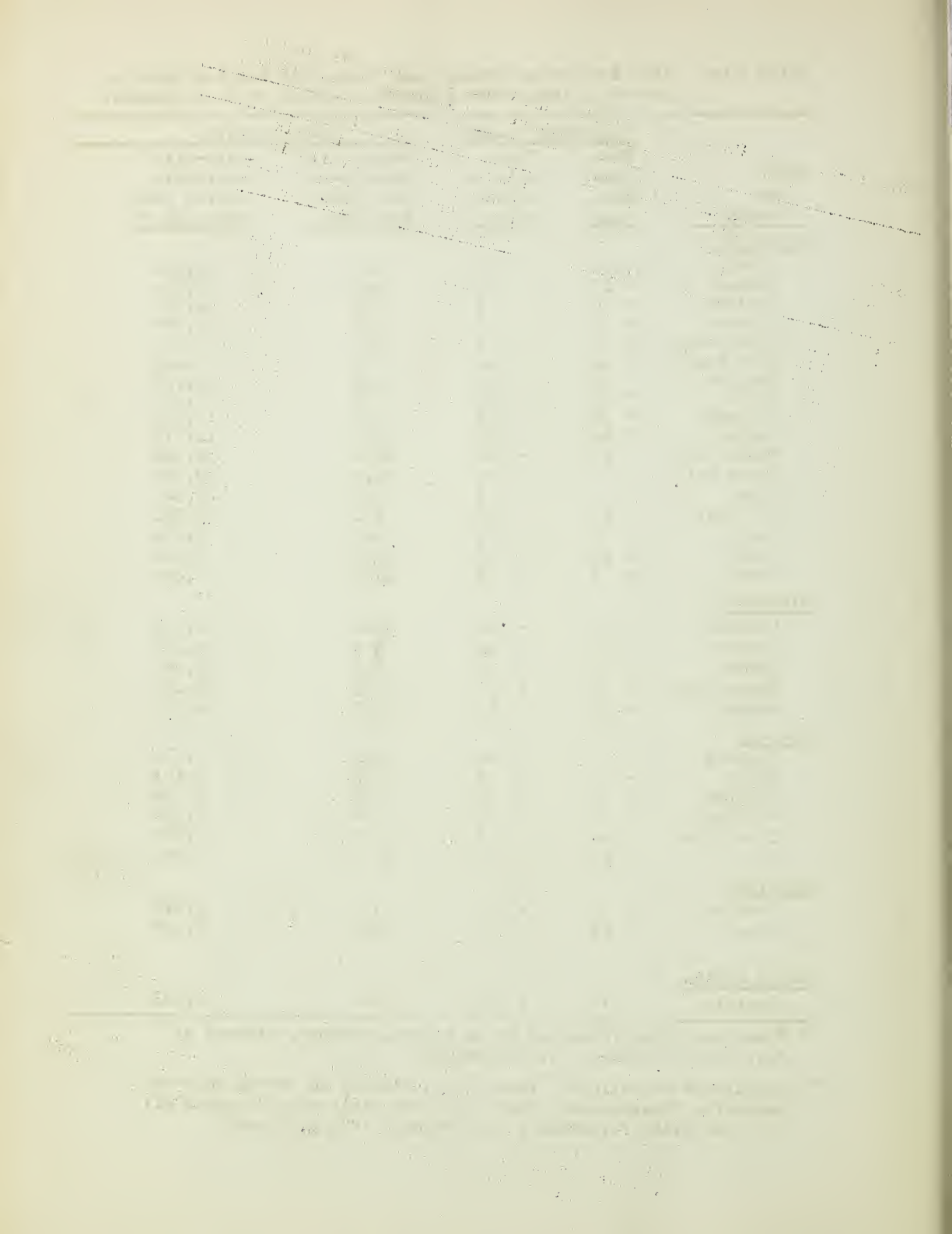
* A county marked with * has no Lend-Lease factory within its borders, but some of its area is served by such a factory.

Table 10-b. Milk Production Trends, and Swine Data for the Counties Served by Lend-Lease Factories. (Based on U. S. Census)

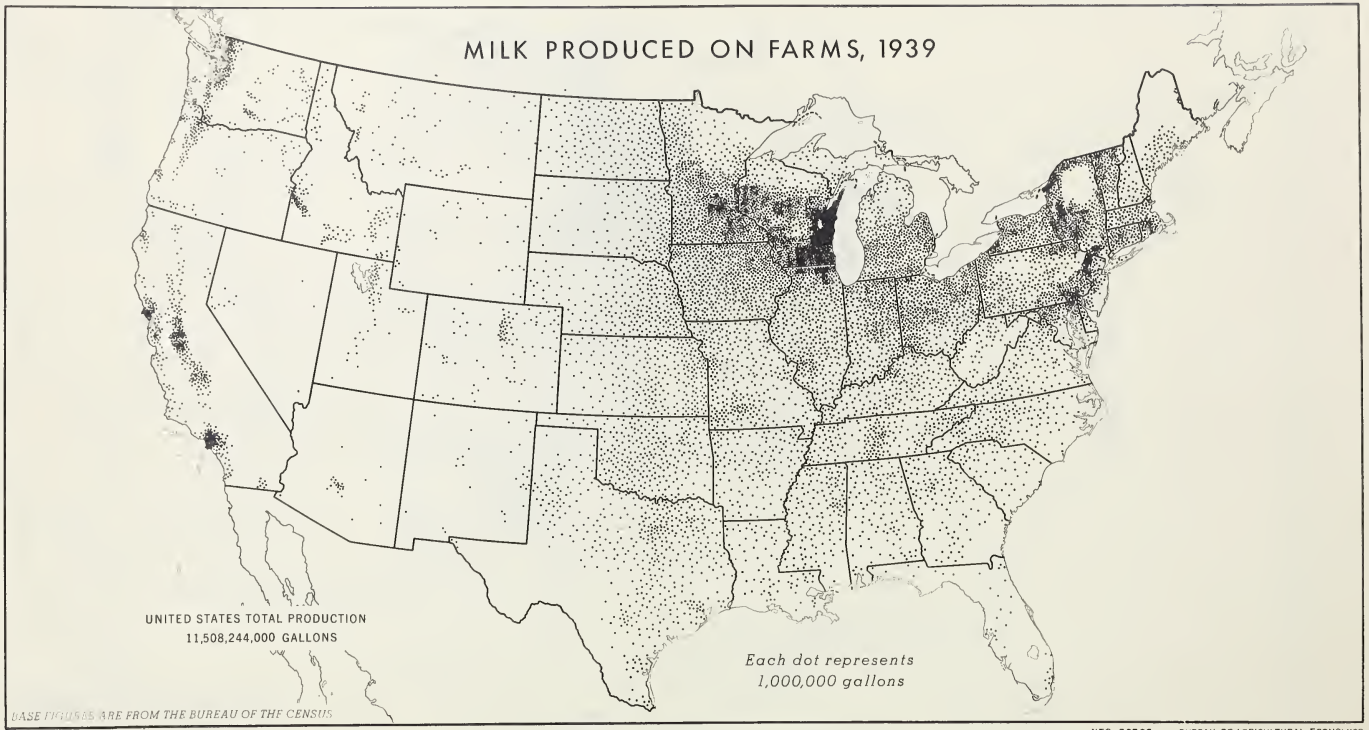
State and County	1930-1940 Trends: Milk production	1930-1940 Trends: Cream sold as butterfat	Sows and gilts: Number farrowed per 1000 acres farm land *	Sows and gilts: Skim-milk available during year for each **
Minnesota				
Aitkin	+ 15	+ 21	4.1	48,931
Becker	+ 19	+ 29	6.0	26,157
Carlton	+ 6	0	2.5	71,352
Carver	+ 2	- 13	36.1	10,066
Clearwater	+ 7	+ 9	3.6	37,367
Crow Wing	+ 81	+ 10	5.5	22,847
Douglas	0	+ 12	14.2	17,990
Itasca	+ 25	+ 36	2.5	47,264
Mahnomen	+ 38	+ 53	7.1	17,541
Meeker	+ 11	+ 16	26.6	11,177
Mille Lacs	- 12	- 12	11.0	31,248
Otter Tail	+ 7	+ 14	10.6	29,589
Polk	+ 3	+ 3	4.2	20,346
St. Louis	+ 12	+ 18	1.1	73,791
Scott	- 3	- 23	30.5	5,451
Sibley	+ 16	+ 18	42.3	6,448
Todd	+ 7	+ 8	18.5	15,406
Wisconsin				
Columbia	+ 4	- 11	18.6	4,663
Juneau	- 1	+ 12	9.5	22,192
Monroe	- 1	- 6	9.6	28,961
Trempealeau	- 3	- 5	12.9	20,447
Vernon	+ 16	- 12	12.7	16,926
I o w a				
Calhoun	+ 9	+ 16	33.3	2,622
Emmet	- 3	+ 1	41.6	3,163
O'Brien	- 6	+ 4	57.2	2,164
Osceola	+ 7	+ 10	49.8	2,702
Palo Alto	- 1	+ 9	45.1	2,885
Sac	+ 14	+ 33	54.7	1,610
Michigan				
Berrien	- 2	- 7	9.6	4,049
Cass	+ 19	+ 33	18.1	6,650
North Dakota				
Traill	- 10	+ 226	6.0	8,123

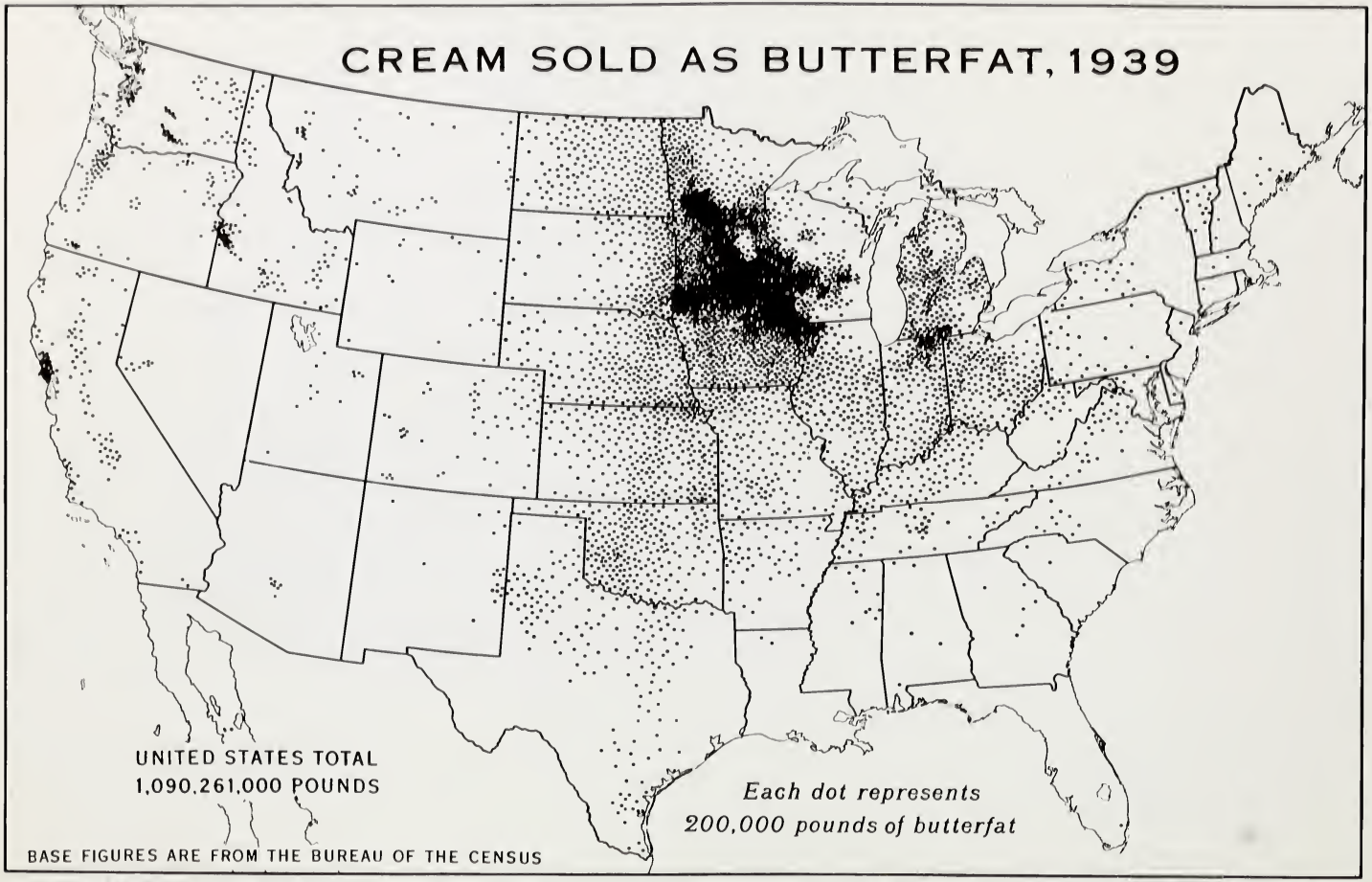
* "Sows and gilts farrowing or to farrow, number", divided by "All land in farms." (U. S. Census)

** Calculated as follows: Pounds of butterfat in "cream sold as butterfat," multiplied by 25, and then divided by "(number of) sows and gilts farrowing or to farrow." (U. S. Census)



Map 1-a

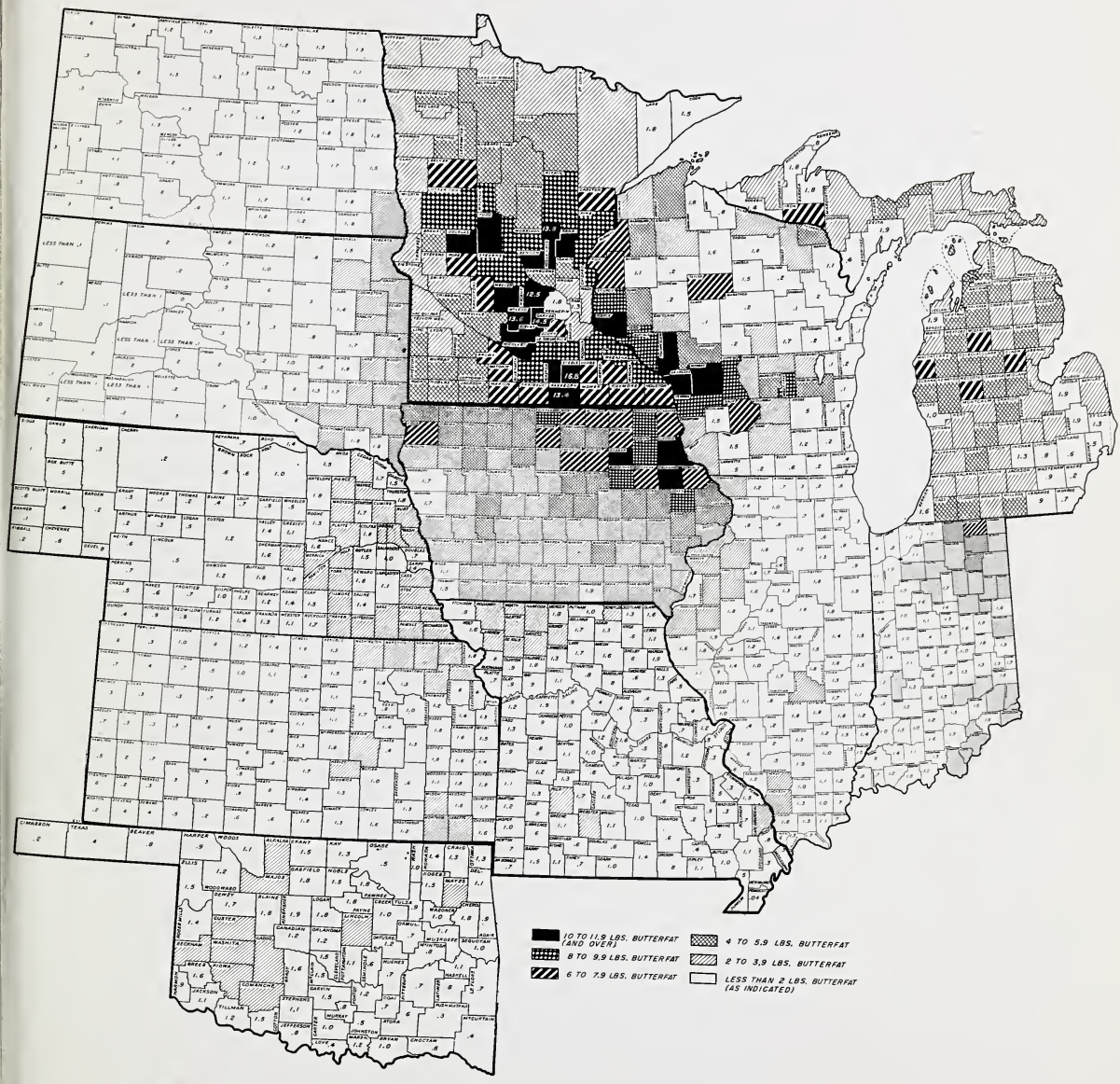

MILK PRODUCED ON FARMS, 1939
UNITED STATES TOTAL PRODUCTION
11,508,244,000 GALLONS
Each dot represents
1,000,000 gallons
BASE FIGURES ARE FROM THE BUREAU OF THE CENSUS.
U S DEPARTMENT OF AGRICULTURE
NEG. 39385 BUREAU OF AGRICULTURAL ECONOMICS



U. S. DEPARTMENT OF AGRICULTURE NEG. 547 AGRICULTURAL MARKETING SERVICE

Map 3-a

POUNDS OF BUTTERFAT, SOLD AS CREAM, PER ACRE OF LAND—1939

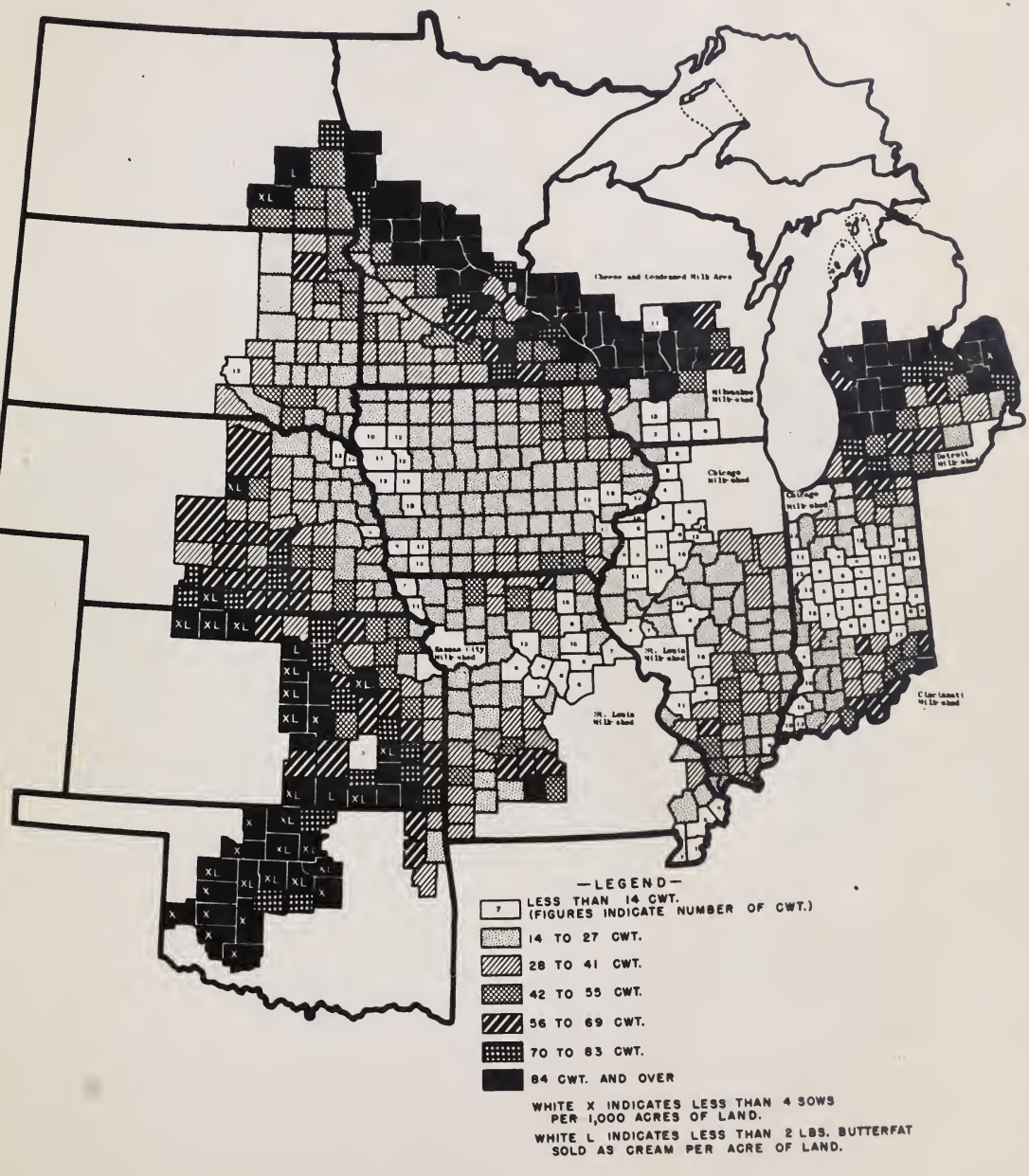


Map 4-a

HUNDRED-WEIGHTS OF SKIM-MILK PER SOW OR GILT.

TWELVE MIDWESTERN STATES, 1939.

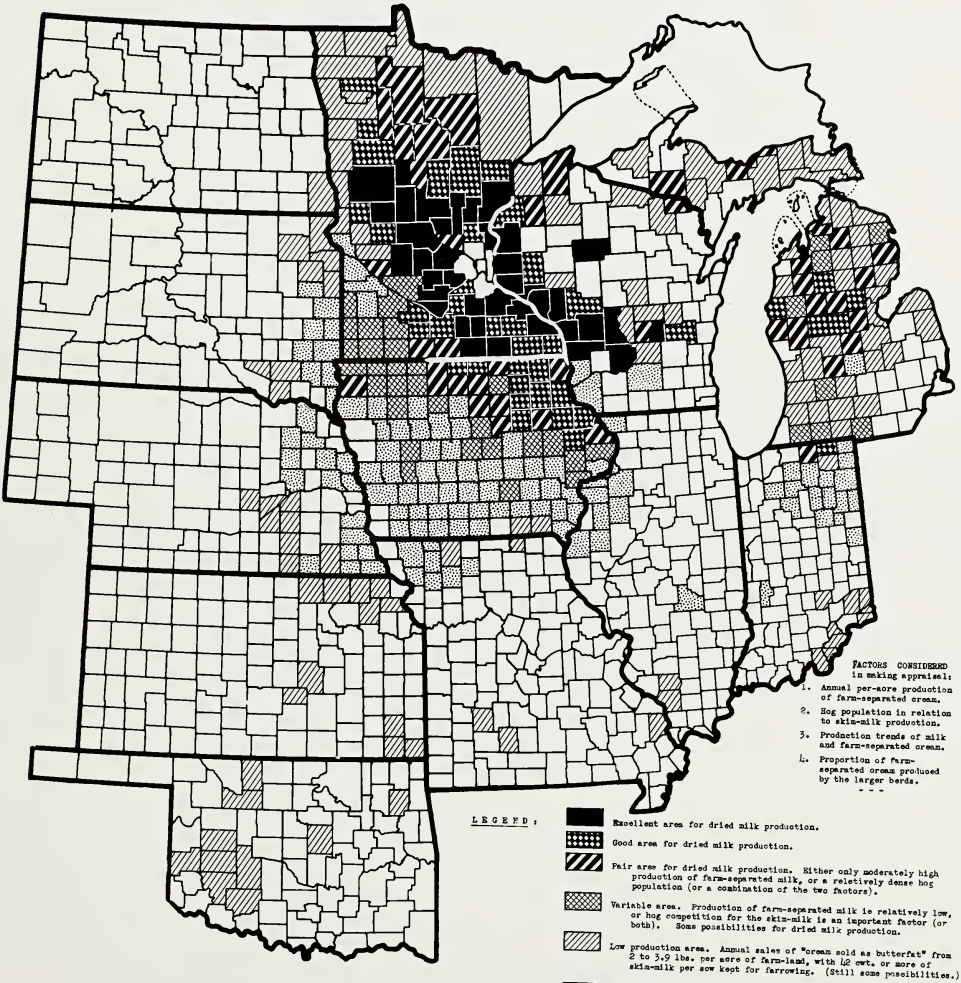
(MAINLY IN THE AREAS WHERE HOGS ARE IMPORTANT)



Map 5-a

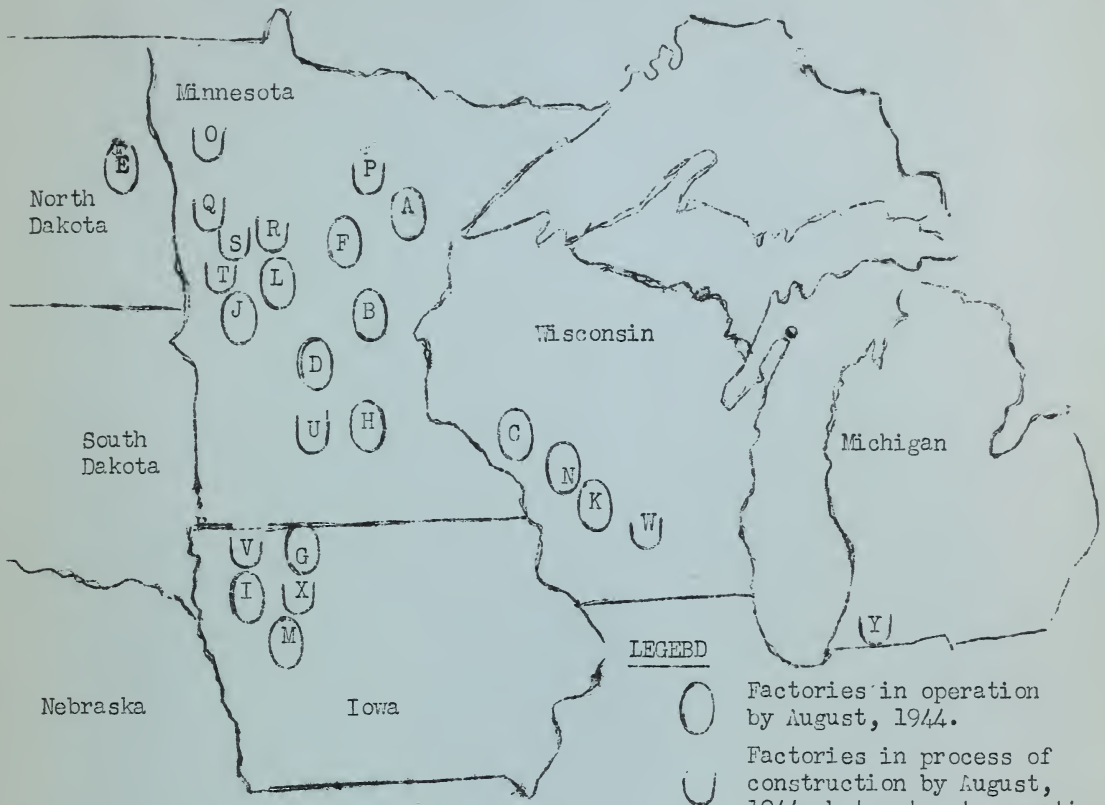
MAP OF THE NORTH CENTRAL STATES

Showing Relative Potential Possibilities for the Production of Dried Milk.
(Based on 1940 U.S. Census data.)



MAP 6 - a.

Location of "Lend-Lease" Milk-Drying Factories



A, Floodwood Co-op., Floodwood, Minn.
B, Land O'Lakes, Milaca, Minn.
C, Land O'Lakes, Whitehall, Wisc.
D, Land O'Lakes, Litchfield, Minn.
E, Traill County Farmers Union, Hillsboro, No. Dak.
F, Land O'Lakes, Brainerd, Minn.
G, Estherville Co-op., Estherville, Iowa.
H, Minnesota Valley Co-op., Belle Plaine, Minn.
I, O'Brien County Co-op., Sanborn, Iowa.
J, Land O'Lakes, Alexandria, Minn.
K, Wisconsin Co-op., Union Center, Wisc.
L, Todd County Co-op., Browerville, Minn.
M, Lytton Co-op., Lytton, Iowa.
N, Kendall Co-op., Kendall, Wisc.
O, Land O'Lakes, Fosston, Minn.
P, Farmers Co-op., Deer River, Minn.
Q, Lakes Dairy, Detroit Lakes, Minn.
R, Land O'Lakes, Sabeka, Minn.
S, Land O'Lakes, Perham, Minn.
T, Fergus Dairy Co-op., Fergus Falls, Minn.
U, Tri-County Co-op., Winthrop, Minn.
V, Osceola County Co-op., Sibley, Iowa
W, Portage Co-op., Portage, Wisc.
X, Farmers Co-op., Ruthven, Iowa.
Y, Producers Dairy, Niles, Michigan.